MCIC'14

ICSIT 2014

March 4 - 7, 2014 – Orlando, Florida, USA

The 5th International Multi-Conference on
Complexity, Informatics, and Cybernetics

The 5th International Conference on
Society and Information Technologies

PROCEEDINGS

Post-Conference Edition

Edited by:

Nagib Callaos
Jeremy Horne
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Organized by
International Institute of Informatics and Systemics
Member of the International Federation for Systems Research (IFSR)

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ISBN: 978-1-941763-00-1

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Tchier, Fairouz	King Saud University	USA
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Wei, Xinzhou	City University of New York	USA
Yamacli, Serhan	Mersin University	Turkey
Zaretsky, Esther	Givat Washington College of Education	Israel
Zelinka, Tomas	Czech Technical University in Prague	Czech Republic
Zhang, Qingyu	Arkansas State University	USA
Zhang, Xiaozheng Jane	California Polytechnic State University	USA
Zobaa, Ahmed	Cairo University	Egypt

ADDITIONAL REVIEWERS FOR THE NON-BLIND REVIEWING

Danielson, Neil	Miami University	USA
De Sá, Eliane	Federal University of Minas Gerais	Brazil
Kirner, Claudio	Federal University of Itajubá	Brazil
Minor, Michael	Health and Human Services Partnership- National Bap	USA
Mohd Shariff, Noresah	University of Science, Malaysia	Malaysia
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Okawa, Keiko	Keio University	Japan
Robbani, Mohammad	Alabama Agricultural and Mechanical University	USA
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ADDITIONAL REVIEWERS FOR THE NON-BLIND REVIEWING

Araujo, Maria Valeria	Federal University of Rio Grande do Norte	Brazil
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Morgado, Lina	Portuguese Open University	Portugal
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Pester, Andreas	Carinthia University for Applied Sciences	Austria
Poobrasert, Onintra	National Electronics and Computer Technology Center	Thailand
Portela Núñez, José M.	University of Cadiz	Spain
Prodan, Augustin	Iuliu Hatieganu University	Romania
Pucher, Robert	University of Applied Sciences Technikum Wien	Austria
Quintanar, Daniel	City of Tucson Water Department	USA
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Rahman, Hakikur	Sustainable Development Networking Programme	Bangladesh
Rajamony, Bhuvenesh	University Malaysia Perlis	Malaysia
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Reyes-Méndez, Jorge J.	University of Toronto	Canada
Röhrig, Christof	University of Applied Sciences Dortmund	Germany
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Salim, Siti Salwah	University of Malaya	Malaysia
Sasaki, Hitoshi	Takushoku University	Japan
Schoenacher, Sheryl	Farmingdale State College	USA
Shetty, Chetankumar	ExperInn Solutions Pvt. Ltd.	India
Silber, Kevin	University of Derby	UK
Soeiro, Alfredo	University Porto	Portugal

Soutsas, Konstantinos	Democritus University of Thrace	Greece
Stein, Sarah	University of Otago	New Zealand
Stosic, Lazar	College for Teachers of Vocational Studies	Serbia
Su, Te-Jen	National Kaohsiung University of Applied Sciences	Taiwan
Suviniitty, Jaana	Aalto University School Chemical Technology	Finland
Szajowski, Krzysztof J.	Wroclaw University of Technology	Poland
Thompson, John	Buffalo State College	USA
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Wu, Tung-Xiung (Sean)	Shih Hsin University	Taiwan
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Adoghe, Loretta	Miami Dade College	USA
Affonso, Thais	Mackenzie Presbyterian University	Brazil
Arditi, David	Illinois Institute of Technology	USA
Bergeron, Francois	TELUQ	Canada
Bernick, Philip	Mesa Community College	USA
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Correa, Lilian	Mackenzie Presbyterian University	Brazil
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Hanna, Vera	Mackenzie Presbyterian University	Brazil
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Kosolapov, Samuel	ORT Braude College	Israel
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Malala, John	University of Central Florida	USA
Mihiotis, Athanasios	Hellenic Open University	Greece
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Mogharreban, Namdar	Southern Illinois University Carbondale	USA
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Sena, José Eduardo	Mackenzie Presbyterian University	Brazil
Shetty, Chetankumar	ExperInn Solutions Pvt. Ltd.	India
St. Amant, Kirk	East Carolina University	USA
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Trevisan, Ana	Mackenzie Presbyterian University	Brazil
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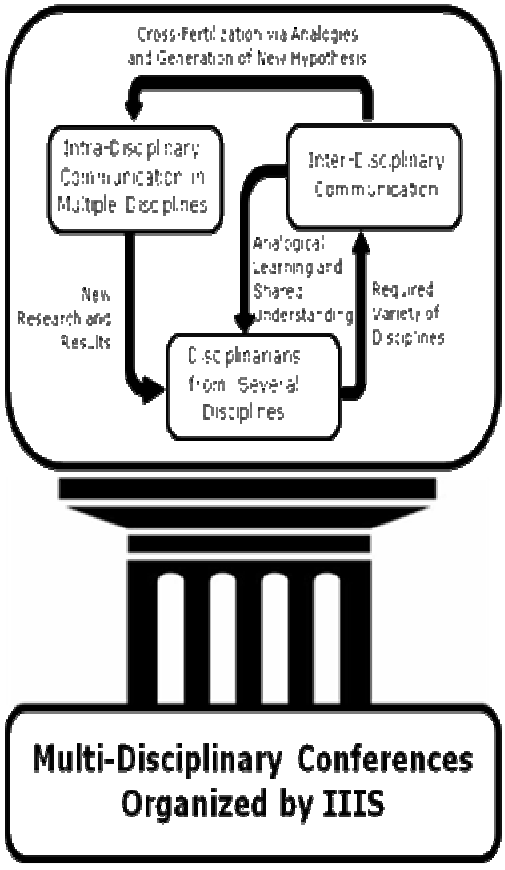
Country	# Papers	%
TOTAL	**60**	**100.00**
United States	17	28.33
Japan	7	11.67
Brazil	6	10.00
South Africa	4	6.67
Turkey	3	5.00
United Arab Emirates	2	3.33
Angola	1	1.67
Argentina	1	1.67
Australia	1	1.67
Canada	1	1.67
China	1	1.67
Egypt	1	1.67
France	1	1.67
Germany	1	1.67
Greece	1	1.67
Hungary	1	1.67
Italy	1	1.67
Kazakhstan	1	1.67
Mexico	1	1.67
Saudi Arabia	1	1.67
South Korea	1	1.67
Sweden	1	1.67
Switzerland	1	1.67
Trinidad and Tobago	1	1.67
Tunisia	1	1.67
Ukraine	1	1.67
United Kingdom	1	1.67

Foreword

Our purpose in organizing The 5th International Multi-Conference on Complexity, Informatics and Cybernetics (IMCIC 2014) jointly with The 5th International Conference on Society and Information Technologies (ICSIT 2014) and their collocated events is to provide a multi-disciplinary forum for both disciplinary and inter-disciplinary communication.

These collocated events were organized and sponsored by the International Institute of Informatics and Systemics (IIIS, www.iiis.org), member of the International Federation for Systems Research (IFSR, www.ifsr.org). The IIIS is a ***multi-disciplinary organization for inter-disciplinary communication and integration***, which includes about 4500 members. Consequently, a main purpose of the IIIS is to foster knowledge integration processes, interdisciplinary communication, and integration of academic activities. Based on 1) the transdisciplinarity of the systemic approach and its emphasis on *relationships* and *integrating* processes, and 2) the multi-disciplinary support of cybernetics' and informatics' concepts, notions, theories, technologies, and tools, the IIIS has been organizing multi-disciplinary conferences as a platform for fostering inter-disciplinary communication and knowledge integration processes.

Multi-disciplinary conferences are organized by the IIIS as support for both **intra-** and **inter-disciplinary** communication. Processes of intra-disciplinary communication are mainly achieved via traditional paper presentations in corresponding disciplines, while conversational sessions, regarding trans- and inter-disciplinary topics, are among the means used for inter-disciplinary communication. Intra- and inter-disciplinary communications might generate *co-regulative cybernetic loops*, via negative feedback, and *synergic* relationships, via positive feedback loops, in which both kinds of communications could increase their respective effectiveness. Figure (at the right side) shows at least two cybernetic loops if intra- and inter-disciplinary are adequately related. A necessary condition for the effectiveness of Inter-disciplinary communication is an adequate level of **variety** regarding the participating disciplines. *Analogical thinking and learning processes* of disciplinarians depend on it; which in turn are potential sources of the creative tension required for cross-fertilization among disciplines and the generations of new hypothesis. An extended presentation regarding this issue can be found at http://www.iiis.org/MainPurpose/



In general, IIIS is an organization dedicated to contribute to the development of the Systems Approach, Cybernetics, and Informatics potential, using both: knowledge and experience, thinking and action, for the:

a) identification of synergetic relationships among Systemics, Cybernetics and Informatics, and between them and society;
b) promotion of contacts among the different academic areas, through the transdisciplinarity of the systems approach;
c) identification and implementation of communication channels among the different professions;
d) supply of communication links between the academic and professional worlds, as well as between them and the business world, both public and private, political and cultural;
e) stimulus for the creation of integrative arrangements at different levels of society, as well as at the family and personal levels;
f) promotion of transdisciplinary research, both on theoretical issues and on applications to concrete problems.

Our objective organizing The 5th International Multi-Conference on Complexity, Informatics and Cybernetics (IMCIC 2014) is to provide, in these increasingly related areas, a multi-disciplinary forum, to foster interdisciplinary communication among the participants, and to support the sharing process of diverse perspectives of the same transdisciplinary concepts and principles. Complexity, Cybernetics and Informatics are being increasingly related to each other in almost every scientific discipline, engineering area, and human activity. Their common transdisciplinarity characterizes and communicates them, generating strong relations among them and with other disciplines. They work together to create a whole new way of thinking and practice. This phenomenon persuaded the Organizing Committee to structure IMCIC 2014 as a multi-conference where participants may focus on one area, or on one discipline, while allowing them the possibility of attending events from other areas or disciplines. This systemic approach stimulates cross-fertilization among different disciplines, inspiring scholars, originating new hypothesis, supporting production of innovations and generating analogies; which is, after all, one of the very basic principles of the systems' movement and a fundamental aim in cybernetics.

One of the main objectives of The 5th International Conference on Society and Information Technologies (ICSIT 2014) and The 2nd International Conference on Education, Training and Informatics (ICETI 2014) is to bring together academics, professionals, and managers from the private and the public sectors, so they can share ideas, results of research, and innovative services or products, in a multi-disciplinary and multi-sector forum.

Educational technologies, socio-economic organizations, and socio-political processes are essential domains among those involved in the evolving co-adaptation and co-transformation between societies and cultures on the one hand, and between informatics and cybernetics (communication and control) on the other hand.

ICSIT 2014 and ICETI 2014 are related to each other, as well as to IMCIC 2014 and, as a whole, are producing or might produce synergic relationships with Information and Communication Technologies. This is why the Organizing Committees have the purpose of combining their efforts in a way that would lead to the organization of an adequate joint event, where academics, researchers, consultants, professionals, innovators, and practitioners from the three areas might relate and interact with each other in the same event. These types of interaction might generate possibilities of cross-fertilization and analogical thinking, as well as possibilities of new working hypothesis, ideas, and reflections on the impact, significance, and usefulness of Informatics and Cybernetics in important dimensions of educational, socio-political, and socio-economical processes, services, and products.

In the context of this purpose the following events were also *tried* to organize:

1. The International Symposium on Integrating Research, Education, and Problem Solving: IREPS 2014,
2. Special Track on Case studies and methodologies: stCSM 2014, and
3. International Symposium on Interdisciplinary Research, Education, and Communication: IDREC 2014.

Cybernetic loops of regulative and positive feedback might generate synergic effects among the three events mentioned above.

We were not able to accept an adequate number of articles submitted to these three events as to organize specific sessions related to each of them. Consequently, we included the papers accepted in these three areas in other sessions with similar topics.

On behalf of the Organizing Committee, I extend our heartfelt thanks to the Program Committees' members, to the 448 reviewers, from 66 countries, who made the **double-blinded** reviews, and to the 178 reviewers, from 51 countries, who made the **non-blind** reviews. (Some reviewers supported both: non-blind and double-blind reviewing for different submissions). A total of 1248 reviews made by 626 reviewers (who made at least one review), from 66 countries contributed to the quality achieved in IMCIC 2014 and ICSIT 2014. This means an average of ***9.313 reviews per submission*** (134 submissions were received). Each registered author had access, via the conference web site, to the reviews that recommended the acceptance of their respective submissions. Each registered author could get information about: 1) the average of the reviewers evaluations according to 8 criteria,

and the average of a global evaluation of his/her submission; and 2) the comments and the constructive feedback made by the reviewers, who recommended the acceptance of his/her submission, so the author would be able to improve the final version of the paper.

In the organizational process of IMCIC/ICSIT 2014, about 134 papers/abstracts were submitted. These post-conference proceedings include about 60 papers, from 27 countries, that were accepted for presentation. The submissions were reviewed as carefully as time permitted; it is expected that most of them will appear in a more polished and complete form in scientific journals. This information is detailed and totalized in the following table, along with the other collocated event:

Conference	# of submissions received	# of reviewers that made at least one review	# of reviews made	Average of reviews per reviewer	Average of reviews per submission	# of papers included in the proceedings	% of submissions included in the proceedings
CICIC 2014	63	187	373	1.99	5.92	25	39.68%
ICSIT 2014	62	307	596	1.94	9.61	27	43.55%
IMCIC 2014	72	319	652	2.04	9.06	33	45.83%
IMCIC&ICSIT	134	626	1248	1.99	9.313	60	44.78%
TOTAL	**197**	**813**	**1621**	**1.99**	**8.23**	**85**	**43.15%**

We also extend our gratitude to the co-editors of these proceedings, for the hard work, energy and eagerness they displayed in their respective activities. We express our intense gratitude to Professor William Lesso for his wise and opportune tutoring, for his eternal energy, integrity, and continuous support and advice, as the Program Committee Chair of past conferences, organized by the International Institute of Informatics and Systemics, and as Honorary President of IMCIC 2014, as well as for being a very caring old friend and intellectual father to many of us. We also extend our gratitude to Professor Belkis Sánchez, who brilliantly managed the organizing process.

Special thanks to Dr. C. Dale Zinn, Professor José Ferrer, and Michael Savoie for co-chairing IMCIC 2014 Program Committee, to Professor Hsing-Wei Chu for his General Co-chairmanship, and to Professor Belkis Sánchez for chairing its Organizing Committee. Special thanks also to Professor Friedrich Welsh for chairing ICETI 2014, Professor José Ferrer and Belkis Sanchez for co-chairing the its Program Committee, and to Professor Andrés Tremante for serving as general co-chair.

We also extend our gratitude to the following scholars, researchers, and professionals who accepted to deliver plenary workshops and/or to address the audience of the General Joint Plenary Sessions with keynote conferences.

Workshops, more details (abstracts and short bios) were included in the Conference Program booklet and at http://www.iiis.org/spring2014plenaryevents/

Professor Leonid Perlovsky, Harvard University and The Air Force Research Laboratory, USA, *Toward Physics of the Mind*

Professor T. Grandon Gill, University of South Florida, USA, *The Case Method for integrating Academic Activities and Inter-Disciplinary Research, Education, and Communication.*

Plenary Keynote Speakers, more details more details (abstracts and short bios) were included in the Conference Program booklet and at http://www.iiis.org/spring2014plenaryevents/

Professor Leonid Perlovsky, Harvard University and The Air Force Research Laboratory, USA, *Basic Principles of the Mind*

Professor David J. Waters, Purdue University, USA, *Making Sense of a World of Words: Wallace Stevens, Interdisciplinary Science Education, and Developing a Vocabulary of Self-Description.*

Professor T. Grandon Gill, South Florida University, USA**,** *Integrating Research, Practice, Education and the Disciplines: The Challenge and One Business School's Approaches*

Dr. Moez Limayem, Dean of the Business School, South Florida University, USA, *Integrating Research, Practice, Education and the Disciplines: The Challenge and One Business School's Approaches*

Professors Houman A. Sadri and Madelyn Flammia, University of central Florida, USA, *Interdisciplinary and Intercultural Education: The Keys to Global Competency.*

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Dr. Hager Kechine, Laval University, Quebec, Canada, *The Effect of Webinar Use on Students' Performance*

Professor Bettina Harriehausen-Mühlbauer, University of Applied Sciences, Germany, *Mobility - a key feature in current projects*

Dr. Joseph M. Woodside, Stetson University, USA, *Forging Industry-Academic Alliances*

We also wish to thank all the authors for the quality of their papers, and to the 813 reviewers (who reviewed at least one article of IMCIC/ICSIT 2014 and its collocated events) for the great job they did making the 1621 reviews that supported the acceptance process. We also extend our gratitude to María Sánchez, Juan Manuel Pineda, Leonisol Callaos, Dalia Sánchez, Keyla Guedez, Marcela Briceño, Freddy Callaos, José Graterol, and Paul Esqueda for their knowledgeable effort in supporting the organizational process, the help desk, and for producing the hard copy and CD versions of the proceedings.

Professor Nagib C. Callaos
IMCIC 2014 General Co-Chair

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Children's Uses of Facebook in Crisis and Peace: A Comparative Study

Prof. Hebatalla EL Semary
Department of Mass Communication, UAEU
Al Ain, 15551, UAE

and

Dr. Mai Al Khaja
Department of Mass Communication, UAEU
Al Ain, 15551, UAE

ABSTRACT

This study is an attempt to investigate children's use of Facebook and the kind of gratification obtained from this use in two different environments, namely Egypt and the UAE, in terms of political movements. Further, this study will identify differences of gratifications obtained by children on Facebook in times of peace and crisis such as popular uprisings in conflict zones and other areas geographically remote from conflict.

Keywords: Children, Facebook 's Uses, Uprisings, Crisis, Peace and Gratifications.

1. INTRODUCTION

Statistics in 2010 indicated that more than 7.5 million children under 13 (the age allowed to be on Facebook) around the world had personal accounts on Facebook and 85% of 9 to 12-year-olds are using Facebook. (1) Surprisingly, it turned out that many parents knew that their children had personal accounts on Facebook and they felt comfortable about it. (2)

Figures have confirmed that more than one third of American young children use Facebook.(3) Another study conducted by London School of Economic studies for the European Commission surveyed 25 thousand children aged between 9 and 16 years all around Europe. The study showed that half of the children in Britain (aged between 9 and 12 years) used social networking sites despite the laws that restricted the age of Facebook use.(4) Moreover, the percentage of Dutch children using social networking sites was the highest (reached 70%) (5). Therefore, those children must have provided incorrect information regarding their ages, whether or not their parents were aware of this fact. Another study indicated that more than one third of children aged between 8 and 11 years circumvented age limits introduced by social networking sites and provided inaccurate personal information (6).

On the other hand, Facebook officials confirm that they delete more than 20,000 personal accounts of underage children daily. They also explain that imposing age limits on internet users is a very difficult process(7).

A survey, involving 1.013 school children between 7 and 12, and 1.002 parents, revealed that 93% of those children uploaded materials they regretted later on. 29% of the children exchanged personal information on Facebook that should not have been exchanged publically (8) However, only 2% of parents thought that their young children might upload naked or semi-naked photos on Facebook (9). Nevertheless, there have been no studies on children's use of Facebook in times of political crisis facing their countries.

Another survey on a sample consisted of 219 students using Facebook focused on comparing school achievements of children Facebook users and non-users. The survey concluded that Facebook users spent fewer hours in studying than non-users [1-5 hours per week (for users) and 11-15 hours per week (for non-users)]. The survey also revealed that Facebook users spent more hours on non-classroom activities, while non-users spent most of their time doing school assignments to get higher marks. Moreover, most of Facebook users confirmed that there were no negative effects of using Facebook on their academic performance except for some time management problems related to checking their Facebook pages and doing their school assignments (10).

As for the Arab countries, statistical releases in May, 2012, indicated that the total number of Facebook users in the Middle East and North Africa was 15.000000 (fifteen million) users. In 2008/2009, the Arab world witnessed an enormous increase in the number of Facebook users who spoke English and French (11). In 2009, Facebook officials' decision of launching Arabic Facebook interface led to a dramatic increase in the number of Facebook users reached 3.5 million users by the end of the year. It is worth mentioning that Egypt and the Kingdom of Saudi Arabia (KSA) came in the first place as each country added 1.1 million users to the total number of Arabic Facebook interface users (12). It is expected that the number of Arabic Facebook interface users will exceed the number of the English ones in the KSA in the near future.

The sources of Dubai School of Government's Governance reported that the UAE came on top in using Facebook on per capita basis, as 45.38% of Emiratis had accounts on the most popular social networking site which ranked the UAE ninth in the world. However, with regard to the number of Facebook users, Egypt came first with 4.634.600 users, followed by the KSA with 3.213.420 users (13).

Notwithstanding the foregoing, there are no reliable statistics on the extent of Arab children's use of social networking sites in general and Facebook in particular. There are no reliable statistics on how Arab children use these networks and the risks associated with such use. In addition, there is no accurate information available regarding the impact of social and political movements on children in their societies and the neighboring ones and how this can affect children's use of Facebook in terms of uses' rates, nature and motives.

Hence, the importance of this study arises from the fact that it attempts to identify the extent of children's use of Facebook in

both Egypt and the UAE. Further, the study discusses how this use is affected by changes of regimes and the outbreak of popular uprisings the Arab region witnessed recently. Since Egypt has a leading role in this political conflict, it has been chosen besides the UAE as a comparative framework for this study for the following reasons:

1.Egypt was one of the first countries affected by the winds of change and uprisings which Facebook was one of their means. On the contrary, the UAE was one of the countries which probably did not undergo any political changes or turmoil recently. Being an essential part of the Arab entity, the UAE supported popular uprisings financially and morally. As a result, the comparison between the two countries will reflect the impact of political movements on children as well as discuss children's role in such change, which may be a minor one.

2. The comparison between the two countries will also define the role of Facebook in building political and cultural awareness among children.

3. The comparison will define the role of parents in both countries and their abilities to provide supervision for their children on Facebook. Moreover, the varying levels of education and computer literacy of parents and children as well as how parents' supervision is affected by political changes in some countries will be taken into account.

2. RESEARCH PROBLEM & THEORTICAL FRAMEWORK

This study is based on Uses and Gratifications Theory as a theoretical framework for underlining the differences of children's use of Facebook according to the social and political environment.(14). Further, this study will identify differences of gratifications obtained by children on Facebook in times of peace and crisis such as popular uprisings in conflict zones and other areas geographically remote from conflict.

3. RESEARCH QUESTIONS & HYPOTHESIS

3.1. Research Questions:

1. To what extent do children in both Egypt and the UAE use Facebook? What are the motives that drive their use of Facebook?

2. To what extent do families supervise children's use of Facebook? To what extent are parents, in both Egypt and the UAE, aware of the risks of Facebook?

3. What are the political, social and cultural risks associated with underage children's use of Facebook in both Egypt and the UAE?

4. How does young children's use of Facebook in conflict zones and other areas geographically remote from conflict differ in times of peace and crisis?

5. What are the gratifications young children obtain from using Facebook that they would not otherwise find on other children-specific social networking sites?

3.2. Research Hypothesis:

1. There is a significant correlation between the motives behind young children's exposure to Facebook and all demographic variables, including gender, age, educational level, economic level and political environment.

2.There is a significant correlation between the gratifications obtained from young children's exposure to Facebook and demographic variables, including gender, age, educational level and economic level.

3. Young children's use of Facebook increases in times of crisis than in times of peace irrespective of the geographical dimension of conflict zones.

4. METHODOLOGY & DATA COLLECTION METHODS

This study is based on survey methodology to monitor young children's (9-12) use of Facebook and the kind of gratification obtained from this use in two different environments, namely Egypt and the UAE, in terms of political movements. Further, the study discusses how these political movements can affect the gratification obtained from using Facebook as well as the nature of and motives behind such use.

A non-probability sample consisted of 400 subjects was distributed as follows**:**

- 100 children from the UAE aged 9-12 years and 100 of their parents.
- 100 children from Egypt aged 9-12 years and 100 of their parents.

This type of sampling was chosen due to the period during which this study was conducted. Data were collected in July and August in 2011 during summer school holidays. In addition, instability conditions in Egypt made it difficult to obtain necessary permits to carry out this study.

It was taken into account that the sample must be representative of government, private and language schools as well as be drawn from males and females. Moreover, the age range (9-12) must be all represented in this sample.

As it is the Capital of Culture and recorded the highest rates of using Facebook, the Emirate of Sharjah was selected as research setting. In Egypt, samples were drawn from Cairo, the capital city, which dominated all Egyptian cities concerning the number of Facebook and Internet users as Decision-Making Support Centre of the Cabinet revealed.

Surveying the parents ensured the veracity of children's responses regarding the extent and nature of their Facebook use. It also assisted in identifying the role of family in encouraging their children to use Facebook or in restricting this use. The nature of family supervision, if any, was examined too.

This study is also based on scientific observation of a number of children's Facebook pages from Egypt and the UAE aged between 9 and 12 years, who allowed researchers to access their Facebook pages and identify their Facebook activities as well as compare the results with the responses of children and parents.

5. RESEARCH FINDINGS:

The results confirmed that the children in both countries agreed on some aspects of daily routine uses and disagreed on the political uses imposed by the nature of the period during which the study was conducted. Details are as follows:

(A) Areas of Agreement:

1) More than half of the participants in the two groups had accounts on Facebook. However, a very small percentage (no more than 17%) had personal accounts on children-specific networking sites, while a considerable number of them never heard of such sites.
2) Both groups did not have accounts on children-specific networking sites and they justified that by claiming none of their peers or friends used those sites.
3) It was confirmed through the responses of both children and their parents that the children did not spend much time on Facebook. However, exposure times to Facebook increased at weekends and in times of crisis.
4) It was also confirmed that the major disadvantage of Facebook use for Egyptian and Emirati children was its negative impact on doing school assignments. The results of our study were consistent with the results of other foreign studies in this regard.
5) The study revealed poor parental supervision of Facebook in both Egypt and the UAE which is demonstrated by the following results:
    a) More than (90%) of parents in Egypt and the UAE were unaware of the terms and conditions of creating Facebook accounts and they did not even know Facebook age limits. We also noticed lack of parents' knowledge of dealing with Internet technology since (78%) of Egyptian parents and (92%) of Emiratis did not have personal accounts on Facebook. Moreover, they never heard of computer software programs that could block Facebook site if the child abused it. As a result, parents are not qualified to have control over their children in this regard.
    b) More than half of parents in Egypt and the UAE knew that their young children had Facebook accounts; however, they did not encourage them to do so.
    c) Most of Egyptian and Emirati children (more than 60%) browsed Facebook alone. Parents confirmed they were unable to supervise their children on Facebook as they did not accept their parents' friendships on Facebook.
    d) A very small percentage of children in Egypt and the UAE (no more than 21%) did not discuss with their parents what they encountered on Facebook. Moreover, it was confirmed that children did not consult their parents about the materials they uploaded on Facebook.
    e) More than (65%) of parents in Egypt and the UAE were not aware that their children could be subjected to various risks because of using Facebook without supervision. Moreover, parents confirmed that their children could not be affected by bad friends on the World Wide Web because they had raised them well. In addition, a considerable percentage of parents confirmed they did not know that their children could be exposed to risks on Facebook. This was consistent with other foreign studies which confirmed that parents were unaware of the risks associated with children's use of Facebook. In addition, (32%) of those parents provided no supervision whatsoever for their children on Facebook.
    f) Parents in Egypt and the UAE stated that the only risk their children could be subjected to on Facebook was learning vulgar and obscene vocabulary. However, children confirmed they saw indecent movies and photos and were tricked by people they met on Facebook. Moreover, children regretted posting information and personal photos on Facebook and they allowed strangers to access their accounts. All this reveals the huge gap between parents and their children.
    g) Parents' inability to supervise their children on Facebook made them resort to 'non-educational' methods if they discovered that their children abused Facebook instead of discussing the mistakes committed. For example, parents might prevent their children from using Facebook, cut off their Internet connection, stop giving them pocket money or even scold their children.

(B) Areas of Disagreement:

As for aspects of disagreement between Egyptian and Emirati children in this study, they are as follows:

1) All respondents declared they were subjected to risks on Facebook; however, they disagreed on the reasons. While Egyptian children confirmed that those risks were not their faults, their Emirati counterparts blamed themselves for being exposed to risks.

2) Children in both Egypt and the UAE agreed that the advantages of Facebook were more than its disadvantages; however, they disagreed on those advantages. While Egyptian children thought that Facebook increased their love for their homeland, became more aware of current events and made them respect the majority opinion, Emirati children assured that Facebook helped them master foreign languages, made them more aware of other cultures and made them more active socially.
3) The children in the two countries agreed on the nature of Facebook disadvantages; however, they disagreed on sorting out the priorities of those disadvantages. While Egyptian children stressed that the major disadvantage was the negative impact on doing school assignments, Emirati children thought that poor communication with parents was the major one.
4) Egyptian children stressed that the greatest advantage they got on Facebook was raising their political awareness. On the other hand, the greatest disadvantages were at the social and educational levels, unlike Emirati children who assured that the advantages they got were mainly at the educational level.
5) Children's responses were not precise in many occasions. For example, they stressed that their uses of Facebook did not differ after the outbreak of revolutions from those before it; however, their responses showed the opposite. Details are as follows:
    a) Children were highly interested in following the news of the most important political figures in the spotlight in the countries where revolutions broke out such as Hosni Mubarak and Bashar Al Assad.
    b) The most followed issues on Facebook were those of Arab revolutions and the rates of Egyptian children viewers of those issues were higher.

6) The results stressed that children's active participations on Facebook were minor and limited to observation and following adults' news and activities. Children did not start groups and their interests were restricted to joining adult ones. That could be interpreted in the context of children's desire to hide their real identities and ages in order to facilitate their integration into adults' world. That was confirmed through scientific observation of some pages of children on Facebook.

7) The results of the study revealed that young children's use of Facebook in times of crisis increased more than those in times of peace with no significant differences between Egyptian and Emirati children in this regard. This confirms that the geographical dimension of conflict zone is of no significance with regard to Facebook uses.

8) It was revealed that there was statistically significant correlation between the motives of young children's exposure to Facebook and all demographic variables including gender, age, type of education, economic level and political environment. However, the relationship between children's social level and the motives of exposure was not proved.

9) Likewise, there was a statistically significant correlation between gratifications obtained from young children's exposure to Facebook and demographic variables such as gender, age, and type of education. However, the relationship between the economic level and the kind of gratification gained by children on Facebook was not proved.

4. CONCLUSION:

Throughout this study, the role played by social networking sites and Facebook in particular was confirmed. Facebook assisted in raising political awareness and the political mobilization of young children. However, political participation among children was almost non-existent due to their young age and their limited naive expertise. As a result, online communication during the crisis was one-way, which led to a lack of interaction particularly during Egyptian crisis. However, no one can deny the vital role of Facebook in launching the initiative of sharpening the sense of belonging to homelands which, undoubtedly, will be reflected in the future and will also assist in creating successful generations that take part in shaping the policy and the future of their countries.

5. REFERENCES

(1) O'Keeffe, G. S. (2011) Cybersafe: Protecting and Empowering Kids in the Digital World of Texting, Gaming, and Social Media (USA: American Academy of Pediatrics)

(2) Cheredar, T. (2011) ,Most parents don't monitor their children's social media activity retrieved http://venturebeat.com/2011/08/09/study-parents-social-media-monitoring/

(3) American Academy of Pediatrics, Council on Communications and Media *Policy statement:* Children, Adolescents, and the Media. *Pediatrics.* Vol. 132 No. 5 November 1, 2013 pp. 958 -961

(4) H Valetk, 'Playing with Privacy: Virtual Communities Raise New Questions', *Law.com* (online), 24 May 2007, <www.law.com>.

(5) Boyd, Danah, Eszter Hargittai, Jason Schultz, and John Palfrey Why parents help their children lie to Facebook about age: Unintended consequences of the 'Children's Online Privacy Protection Act', *First Monday*, Volume 16, Number 11 - 7 November 2011

(6) Nielsen, Jakob (2010)Children's Websites: Usability Issues in Designing for Kids retreived from http://www.nngroup.com/articles/childrens-websites-usability-issues/

(7) Wolford , J. (2013**)** Facebook Still Has a Big Problem with Underage Users, and They KnowIt,http://www.webpronews.com/facebook-still-has-a-big-problem-with-underage-users-and-they-know-it-2013-01

(8) J Wyn and others, *Young People, Wellbeing and Communication Technologies [Prepared for Victorian Health Promotion Foundation]* (2005) Youth Research Centre, University of Melbourne, 14–17.

(9) M Hersh, 'Is COPPA a Cop Out? The Child Online Privacy Protection Act as Proof that Parents, Not Government, Should be Protecting Children's Interests on the Internet' (2001) 28 *Fordham Urban Law Journal* 1831, 1870.

(10) Kirschner , P.A.& Karpinski , A.C.(2010) Facebook & Academic Performance, Computers in Human Behavior , Volume 26 Issue 6, Pages 1237-1245

(11) Zaki, S. (2008) Internet and its impact on Egyptian young people: Sociological study, MA thesis, (Egypt: Sociology department, faculty of Arts.)

(12) Ministry of Communications and Information Technology (2010) Large numbers of children using social networking sites, , Saudi Arabia, retrieved from http://www.mcit.gov.sa/Ar/Communication/Pages/Internet/Internet_72.aspx

(13) Al Saleh, Nazar (2013)Children and the Internet, , Islamweb.net retrieved from http://articles.islamweb.net/media/index.php?page=article&lang=A&id=101757

(14)Blumler, J.G.& E. Katz (1974) The Uses of mass Communication. Newbury Park,CA:Sage

Wheel Guide – mobile navigation for barrier-free walkways

Bettina HARRIEHAUSEN-MÜHLBAUER
Computer Science Department, University of Applied Sciences
Darmstadt, 69121, Germany

ABSTRACT

Modern information technology can improve life in many places and situations in our society. This includes the improvement and simplification of life for people with special needs. We have developed a mobile navigation tool called Wheel Guide, which combines modern mobile information technology, such as smartphones and their programming, with existing navigational technology, meeting the goal to serve specific needs for people with special needs. In comparison to existing tools, we concentrate on barrier-free routes rather than barrier-free buildings and our enhancements include:

- the marking of barriers on a chosen route,
- an intelligent computation of a detour in case the chosen route contains barriers,
- the customization of the app by defining your personal profile(s),
- the opportunity to include both static as well as temporary barriers, and
- a high degree of interactivity which enhances the app steadily.

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Keywords: Mobile navigation, Calculation of barrier-free walkways, Customization based on degree of impairment, Mobile insertion of static and temporary barriers, Enhancement through interactivity.

1. INTRODUCTION

Steep ramps, stairs (German: Treppe), bouldering and other uneven footpath surfacing are often insurmountable barriers for the mobile handicapped or wheelchair users. On the basis of the geographical data of OpenStreetMap [4], we have developed a mobile navigation app which enables mobility impaired people to navigate from A to B on a barrier-free route. In addition to commonly known features of navigation systems, we are using the points of interest (POI) feature and their geo dataset to add barriers to the maps. Therefore, according to our definition, POIs are not tourist sights, gas stations or restaurants, but rather geographical positions that mark barriers for the mobile handicapped, such as steep ramps, narrow passages, staircases, construction sites or uneven surfaces.

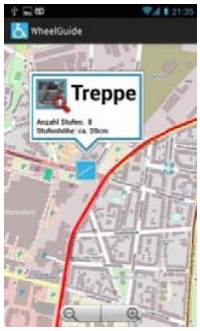


Fig. 1. Display of a barrier (German: Treppe;= stairs) along a selected route

2. RESEARCH AND RELATED WORK

During our initial research, we investigated several wheelchair navigation and support systems and found that they all differ heavily in their functionalities as well as their product status. Excellent tools, such as WheelMap [8], focus on barrier-free buildings rather than routes, and systems with a similar focus to ours, such as Rollstuhlrouting.de [7] or EasyWheel [1] haven't left their prototype-status yet or do not cover all of the features that we have focused on. After a general research regarding related work, we concentrated our research and the following design of the system on direct contact and interviews with wheelchair users. This led us to the definition of the following barriers, which can be added to the map by the users interactively: ramps, narrow passages, stairs, and various insurmountable surfacing. We have developed self-explanatory icons for all of those barriers. In addition to statics barriers, users can also add temporary barriers (marked by a red clock symbol), such as fallen trees or temporary construction sites. Presently, these temporary POIs are being automatically removed from the map after 2 days, unless another user renews its existence.

Fig. 2. Icons for barriers (ramp, narrow passage, stairs, temporary construction site)

3. DESIGN

We are using the traffic light metaphor to mark the selected paths according to the feature of being passable or not, i.e. whether they are barrier-free or not. In our app, "passable" is either defined by a standard profile or can individually be defined by the user, as certain barriers may cause difficulties for some users but not others; i.e.

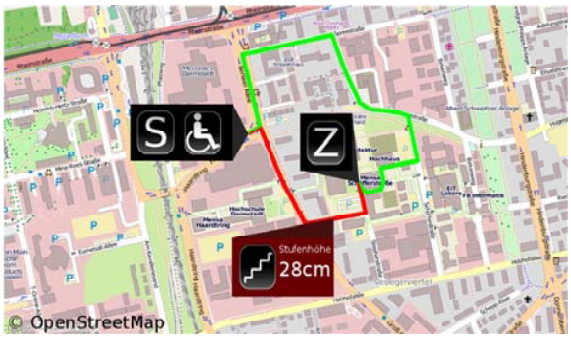


Fig. 3. Display of a barrier (staircase with steps of 28 cm height) along a selected route (red) and computed barrier-free detour (green)

several members in our testing group were able to climb staircases with several stairs, whereas others would not be able to mount low steps. In case the path is barrier-free, it is marked as a green route from S (start) to Z (goal, German: Ziel). A path marked yellow contains barriers, which may cause difficulties for certain people but not others, i.e. the user can individually decide whether or not s/he wants to select that route. In case the app detects a barrier along the shortest route, that route will be marked red and a barrier-free (green) alternative will be computed automatically. In all cases, the user can always select to view the barrier along the route and will be shown the details for the barrier, which includes the icon as first information on the type of barrier, but in addition also text which specifies the barrier, such as the number of stairs and the height of the stairs. In case a photo was added for the barrier before, the user can also choose to view that photo. All this information helps to decide whether or not the barrier can be surmounted or not.

Fig.4. Wheel Guide GUI

The look & feel of the app is designed so it can be used without major explanations and is. Each GUI is held very simple without overloaded functionalities. The icons we developed for the barriers (see ch. 2) and the functionalities are self-explanatory:

Fig.5. Icons (from top left to bottom right): compute a route, show map, show profile, add a profile, active wheelchair, electric wheelchair, wheelchair with companion, navigation

4. FUNCTIONALITIES

Customization

For users who choose not to define their individual profile, we have predefined three standard profiles (Fig.6a), one for active wheelchair users, the second one for users of electric wheelchairs, and the third one for

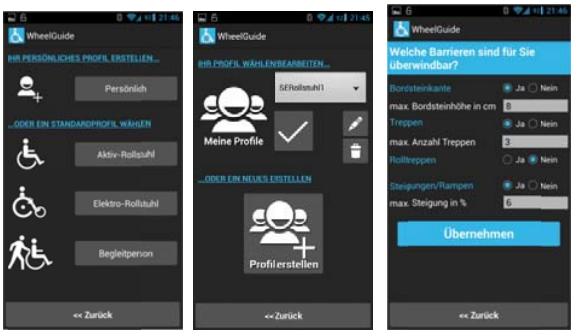


Fig.6. (a) Selection of a profile, (b) Definition of an addition profile, (c) Customization of individual profile, here: Which barriers are surmountable for you? Curbstone with its height, stairs with the number of steps, escalators, ramps and their degree of incline

wheelchair users who have a companion, who helps them to move. Beyond these standard profiles, each user can define one or more individual profile (Fig.6b). Our users' feedback has shown that not only do the individual profiles vary on a daily basis, but the range of what is regarded as a barrier can vary tremendously among wheelchair users of the same type of wheelchair. Some users were able to climb staircases with a relative high number of steps, others would already consider low steps unsurmountable. Our app guides the user through the definition of an individual profile (Fig.6c).

The marking of barriers

We distinguish between two types of barriers: permanent and temporary barriers. Examples for permanent barriers are staircases and ramps, temporary barriers can be temporary construction sites which make a passage unpassable or fallen trees. Once a temporary barrier is included into the map, it will be automatically removed after two days, unless it is re-entered by the same or another user.

Permanent barriers: There are three possibilities for permanent barriers to appear in the app:
(a) they are predefined by OSM,
(b) we include them into the OSM maps before distribution by using the POI feature and current GPS position to include a "point of interest", i.e. one of our barriers, or
(c) the second option is performed by one of our users interactively, i.e. the app and its correctness of barriers will grow by using it.

Temporary barriers: There are two possibilities for temporary barriers to appear in the app:
(a) they are interactively included by users when they see

or experience a temporary barrier, or
(b) they are included by the road traffic licensing departments of cities which decide to use the app as a means to receive and distribute data about temporary barriers.[1]

Interactivity

The marking of barriers, and thus the correctness and completeness of the app, depends to a high degree on the interactivity of the users. When experiencing or seeing a permanent or temporary barrier that is not included in the app yet, the user can include it by using the GUI shown in Fig.7, which asks to report and include a barrier (German: Barriere melden), to specify the type of barrier (German: Barrierenart), here: ramp, to specify more detailed information on the barrier (German: Steigung in %), here: the degree of incline, and to optionally take a picture of the barrier, so future users can decide upon the picture whether or not the barrier will cause difficulties. In case of a ramp, the user may decide, and later see, the image in Fig.8.

Fig.7. Reporting and adding a new barrier

Fig.8. Image of a ramp taken by a user and added to the POI-barrier-information

After the new barrier is added to the app, its position is marked on the map with the corresponding icon. Upon selection (touch or roll-over) the additional textual information is given, as well as a thumbnail image of the barrier, in case a picture was previously added. In that case, the image can be enlarged.

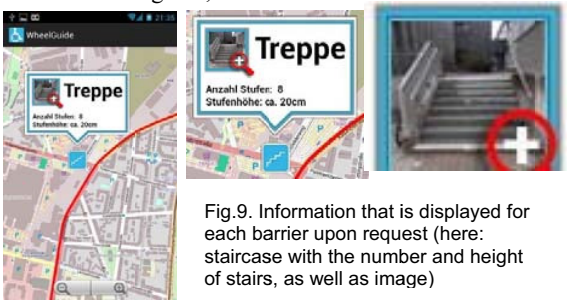


Fig.9. Information that is displayed for each barrier upon request (here: staircase with the number and height of stairs, as well as image)

[1] Note: In Germany, temporary barriers, such as temporary construction sites, have to be reported to the city's road traffic licensing department before the barrier is set up. But of course, barriers such as fallen trees cannot be reported beforehand.

Computation of individual, barrier-free routes

The basis of our route computation is provided by the free navigation tool OpenStreetMap (OSM), which provides map data for locations worldwide. Independent of Wheel Guides functionalities, users can use OSM to compute an individually chosen route, depending on their means of transportation (e.g. by car, by bicycle, by foot). As Wheel Guide users will never choose highways or big country roads without footpaths along the side as their routes, those are blocked in our algorithm. We use OSM's information on barriers as well as our added barriers to computer the shortest possible path for each user depending on his profile. In case an unsurmountable barrier is detected on the shortest path, that path will be marked red, the barriers will be displayed and a barrier-free detour will be computed and shown as a green route. In case barriers are detected which may cause difficulty, but the user should decide whether or not they can be handled, the routes will be displayed in yellow color and the barriers are displayed with all information that is available in our database.

5. IMPLEMENTATION & TECHNOLOGY

HTML5

In a first step, we started developing the app for Android platforms, but soon found that this was an unacceptable limitation, as the mobile market is much too diverse and dominated by at least 4 "key players": Android phones, Apple's iPhones with iOS, RIM's Blackberry and Windows Phones. And apart from the mobile market, we also wanted to offer our navigation tool to users without smartphones and to those in general who want to compute their routes from their homes. Therefore, we have chosen to develop an HTML5 website which makes it possible to inform users without smartphones about barriers and to plan routes from home. In addition, it saved us development time, which we would have had to invest if we had chosen to develop the app for all available platforms natively. By having chosen HTML5, all users can access our app, even if their smartphone is not natively supported, as they can use the browser alternative instead. This way, the web version of our app can be used via browsers on hardware which we do not explicitly support.

Open Street Map

We have chosen Open Street Map (OSM) [4] as the underlying map, as its interfaces enable us to add data to the existing maps, i.e. our barriers as "points of interest", and we can access its data, which enables us to extract the information that we need to compute ideal routes for our individual wheelchair user. The data that we extract from OSM includes ways and their nodes, as well as all barriers, such as steps, inclines, curbstones and the nature of the ground, such as soil conditions. All these data are

needed to check which ways and nodes exist and which ones are passable according to the user's profile. The ways and nodes include feature-value pairs, called tags. Examples of such tags are: surface=cobblestone, surface=grass, smoothness=intermediate, incline=*, and width=*, including the gradient of the incline in percent or the width of a passage in meters[2]. The tags are accessed via the Overpass API [5], which returns custom selected parts of the OSM map data. It acts as a database over the web: the client sends a query to the API and gets back the data set that corresponds to the query [6].

An XML file is being returned which is loaded by the server and used in the next processing step in which the single nodes and ways from the file are translated into Java objects which contain the ID of the objects and their information about barriers as a key-value-pattern. An example for an entry for a staircase could be highway[3] = steps and step_count = 5 for 5 steps. When a user sends a route computation query, these data are compared with the user's profile by the route computation algorithm in order to check which ways and nodes are passable or not.

GPS

The entire computation of the routes, the detours and the barriers is based on GPS data which is provided by HTML5's geolocation functions, which include functions for error handling, the availability of the location functions, and the query of the position. When the latter is called from the mobile device, the current GPS data is sent. In case the app is used via a browser, the position is estimated by means of the device's IP address and the possibly existing WLAN signal. In cases where only the IP address is known, the accuracy of the position is not very exact and can only be shown for a general region, e.g. metropolitan area of a city, meaning an accuracy of approximately 25-150 km.

Fig.10. Marking of the position based on the IP address only

In cases where we have a WLAN signal known by Google, an accuracy of approximately 0.5 m is theoretically possible. Our experience and tests have shown that the accuracy in a large city is usually between 30 and 75 m. But because we only need to access these possibilities when no GPS signal is available, this scenario is limited to stationary computers in residential homes. In these cases a vague positioning doesn't cause problems, as the user doesn't need to find or locate his position on a map, as he knows where he lives, but it's rather used to simplify the use of the map.

When using the web-version of Wheel Guide, the browser will ask for permission, each time the position is being computed. With the mobile version this step happens automatically, as the app will be permanently authorized to access the GPS function upon download.

Computation of routes and barrier handling

The most prominent feature of our app is the handling of barriers and the resulting computation and drawing of a barrier-free route. In order to check whether the chosen route contains barriers, we compare the list of tags and values which exist for each node and way with the individual profile of the user (shown on the left of Fig. 11). This will tell us whether the route is passable and barrier-free (drawn as a green route) or not.

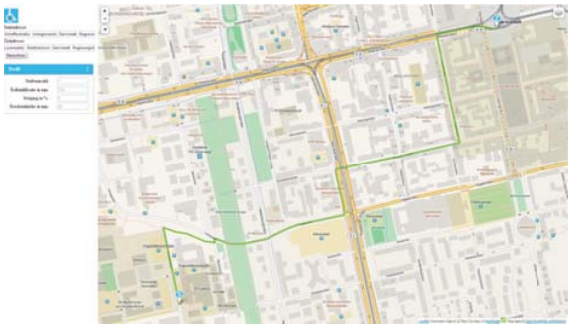


Fig.11. Computing and drawing a route based on a profile which allows 1 step (German: Stufenanzahl), widths of 735 cm (German: Rollstuhlbreite in mm), an incline gradient of 6% (German: Steigung in %), and curb heights of 30 mm (German: Bordsteinhöhe in mm)

We are using the Dijkstra-algorithm [2] to compute the optimal route for our users. This algorithm computes the shortest path for a given start-node and one (or more) target-nodes, in our case the goal or location the user wants to travel to.

In OSM and our database an intersection is called *node* and a street or path is called *way*.

First, the start- and target-nodes are determined by selecting the nodes from our database which are closest to the selected start- and target-nodes. Starting from these (database) nodes, the algorithm will check for the next nearest nodes. These will be connected by ways. In case the connecting way is impassable for wheelchair users due to barriers, this node will be ignored. For all nodes that can be reached on a barrier-free way, the distance

[2] The complete list of tags we use from OSM can be looked up here: http://wiki.openstreetmap.org/wiki/DE:Rollstuhlfahrer-Routing#Tags_f.C3.Bcrs_Routing

[3] The OSM attribute *highway* is used for any way that is developed, as opposed to dirt tracks or trails.

between the nodes will be computed and stored for further computation.
Once the distances between the start node and all reachable nodes are stored in the reachable nodes, the start node will be marked off as „visited“ and will be ignored until the goal node is reached. The following steps will then be processed in this order:
1. Look for the node with the shortest distance and which hasn't been visited yet.
2. Compute the distances to all reachable nodes and record the distance in case no value has been entered yet or the distance is shorter than the previous value.
3. Return to step 1. until the node with the lowest value and which hasn't been visited yet, is the target-node.

This process will be repeated twice in order to compute a green and a yellow or red path. After first trying to find a green path, the process will be repeated for a yellow or red route. The yellow route will include the user's profile data for yellow routes, i.e. barriers, which are surmountable for some users or under certain circumstances. In case barriers are detected along the chosen route, they will be buffered in the data for that route in order to be retrieved and included in the app later upon request of the user. At that stage, the user can decide individually, whether the barriers are surmountable for him or not. When computing and drawing a red route we do not include profile data, as those routes are not surmountable under any circumstances and the app will always draw the shortest route.

Depending on the result of this computation process, the function *pathdraw* [see Fig. 12] will draw the computed route in the appropriate color:

```
public void pathDraw() {

    StrictMode.ThreadPolicy policy = new
    StrictMode.ThreadPolicy.Builder().permitAll().build();
    StrictMode.setThreadPolicy(policy);


    road = new Road(pRouteGet());
    PathOverlay pathOverlay = RoadManager.buildRoadOverlay(road,
    mapView.getContext());

    pathCalculate();

    switch (pType.charAt(0)) {
        case 'd' :
            pathOverlay.setColor(Color.GREEN);
            break;
        case 'Y' :
            pathOverlay.setColor(Color.YELLOW);
            break;
        case 'R' :
            pathOverlay.setColor(Color.RED);
            break;
    }
    Paint pPaint = pathOverlay.getPaint();
    pPaint.setStrokeWidth((float) (pPaint.getStrokeWidth() + 2.0));
    pPaint.setAntiAlias(true);
    ;
    pathOverlay.setPaint(pPaint);


    mapView.getOverlays().add(pathOverlay);
    mapView.invalidate();

}
```

Fig.12. Pathdraw function – drawing routes in different colors according to the computed passability for the individual user

6. TESTING

During the entire process of design and development, we worked closely together with a group of wheelchair users. Their constant feedback enabled us to find bugs and optimize the app appropriately.

Fig.13. Wheelchair users testing the Wheel Guide app

7. CONCLUSIONS & NEXT STEPS

The initial feedback from users after the app was launched showed us that we were on the right track. The community of Wheelchair users responded very positively and together we have defined more functionalities, which we have started to build into Wheel Guide. These include: barrier-free toilets along the routes, barrier-free means of public transportation along the routes and barrier-free locations of common interest, such as cafés, restaurants, or supermarkets, therefore combining the initial routing idea with functionalities known from systems which concentrated on the implementation of barrier-free buildings. We are presently in the process of finding such information in existing tools and defining interfaces to connect existing information with Wheel Guide. An example is shown in Fig. 14, which displays a MapQuest [3] map of Rödermark, a small town south-east of Frankfurt/ Germany, which includes and displays barrier-free toilets:

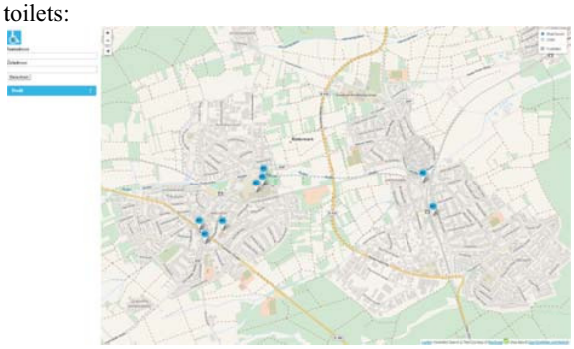


Fig.14. MapQuest map displaying barrier-free toilets

8. REFERENCES

[1] C. Menkens et.al., "EasyWheel - A Mobile Social Navigation and Support System for Wheelchair Users", **Proceedings 2011 Eighth International Conference on Information Technology: New Generations**, Las Vegas, Nevada USA, April 11-April 13, 2011.

[2] **Dijkstra Algorithm** http://en.wikipedia.org/wiki/Dijkstra%27s_algorithm , last access Dec. 6, 2013

[3] **MapQuest** http://www.mapquest.com/, last access Dec.6, 2013.

[4] **OpenStreetMap** http://www.openstreetmap.org/, last access Aug.6, 2013.

[5] **Overpass API** http://overpass-api.de/, last access Dec. 6, 2013.

[6] **Overpass API** http://wiki.openstreetmap.org/wiki/Overpass_API, last access Dec. 6, 2013.

[7] **Rollstuhlrouting project** http://www.rollstuhlrouting.de/, last access Aug.6, 2013.

[8] **Wheelmap project** http://wheelmap.org/, last access Aug.6, 2013.

Method for Improving Students' Programming Skills

Yasuyo KOFUNE
Osaka Prefectural Yodogawa Technology High School
Osaka, Japan

and

Takahiro KOITA
Doshisha University
Kyoto, Japan

Keywords: Programming Education, Agile Development, Mind Map, UML, Pair-programming,

1. Research Goal

This study aims to suggest a class design not only to teach students how to write a program by using Agile Development but also to provide hands-on experience and practical knowledge through the process of creating such software as students have used on a daily basis.

2. Background and Motivation

While Japanese high-school students in a technical course usually have learned program languages since their enrollment, most of those students cannot create software by themselves. Many students are not interested in the essence of programming because sample programs in textbooks are difficult for high-school students, and they tend to think programming is not an interesting activity.

Existing techniques of teaching programming languages in Japan are not sufficient to support learning due to the lack of hands-on experience. Moreover, many students are not good at thinking by themselves to solve a problem, or conveying their ideas to others.

To work as an active engineer in the future, logical thinking and problem-solving ability are required in addition to programming skills. To acquire such abilities, it is important that students learn programming languages voluntarily.

3. Our Approach

To acquire such abilities, *Agile Development* can be useful for students. Agile Development is an umbrella term for several iterative and incremental software development methodologies. The following two points illustrate the principle of agile declaration [1].

- The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
- Working software is the primary measure of progress.

Based on the principle of agile declaration, students can study a program language, software design, and a user interface.

First, students check the structure of a certain completed software, and then discuss how to divide software into small functional units and examine the function of their software.
To complete their software, the students need to share a mutual idea, and all members need to know about the entire software. Therefore, students create a *Mind Map* of their software's structure and function. A Mind Map is one of the ways of thinking that Tony Buzan advocated [2].

Next, students can learn to model software using Unified Modeling Language (UML). UML is a standard of the general-purpose modeling language in object-oriented programming [3]. Students create the use case diagram of UML based on the Mind Map showing the structure of the software created before. Those students check whether each function is important or not for users. Moreover, the students design the structure of software using the object diagram and class diagram of UML.

The students write a program based on the UML diagram in the previous process. The students explain the program that they create to other students. The program that each student creates should be shared among students. By using pair-programming, students can cooperate and write a program. Pair-programming is a technique for developing one program by two persons. It is well used by Agile Development. Finally, they can join a program with a functional unit, and students complete the software.

Figure 1 shows the overall flow that students tackle. The Agile Development technique values a member's communication and repeats the development process. Similarly, students of our approach also reexamine the entire software, test each function of the program and develop mutual work conditions.

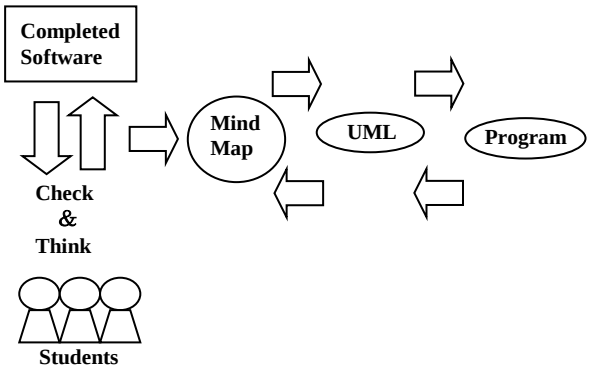


Figure 1: Overall Flow of Our Approach

4. Conclusion

Students consider the demand for software and how to make software they also want to use. Students learn not only how to write a program but also about software design. The students write a program in a small functional unit, learn how to execute and experience a small success. This small success helps students stay motivated. Through the process of trial and error for completion of the software, the students solve many problems in cooperation with each other. By introducing our method based on Agile Development, students thought weak in writing programs can learn many things from the programming process, and also acquire logical thinking, problem-solving, and communication abilities.

5. REFERENCES

[1] Manifesto for Agile Software Development, http://www.agilemanifesto.org/.
[2] Tony Buzan - Inventor of Mind Mapping, http://www.tonybuzan.com/about/mind-mapping/.
[3] UML: Object Management Group, http://www.uml.org/.

Digital Inclusion to promote Social Inclusion

Marcelo Franco Porto
School of Engineering
Federal University of Minas Gerais
Belo Horizonte, Brazil
marcelo@etg.ufmg.br

Renata Maria Abrantes Baracho
School of Information Science
Federal University of Minas Gerais
Belo Horizonte, Brazil
renatabaracho@ufmg.br

Marcello Martins Soares
Cristiano Maciel da Silva
School of Engineering
Federal University São João del Rei
Ouro Branco, Brazil
cristiano@ufsj.edu.br

Abstract – This research analyzes the methodology and the results obtained in the Digital Inclusion Program of the community of Alto Paraopeba aiming the social inclusion of participants. The program had begun in 2008 at Campus Alto Paraopeba - Federal University of São João del Rei. It comprises a team of students, teachers and technicians from the University with support from Pro-Deanship at UFSJ. In 2010, it was contemplated by the Support Program for University Extension of MEC (Ministry of Education and Culture). This study evaluated a group of 153 people in the community who participated in the program to identify the motivating factors for learning and the parameters that indicate the level of knowledge attained and consequently knowledge generation and social inclusion. The program aims to promote digital inclusion of communities in the region to enable access to information technology to people who lack these resources and can´t reach individually. The program has UFSJ's partnership with the municipalities of Ouro Branco, Congonhas and Conselheiro Lafaiete (municipalities of Minas Gerais). Activities include attendance at lectures, development and submission of practical work. The first stage was to survey and mapping of the assist social sites. The second stage of this research described the disclosure of the program and the selection of participants in the community. The third step was the observation of the meetings of the digital inclusion program in the laboratories of UFSJ to monitor the development of activities. The fourth was performed using quantitative methods for monitoring the participants. The questionnaires were applied in three different stages: beginning, middle and end. The fifth stage used a qualitative analysis. It was performed through interviews, aiming to obtain the views of participants and a significant set of discursive material. Through the questionnaires it was possible to analyze the development of participants as well as evaluate the effectiveness of the program. The results proved the effectiveness of the program that may say that 100% of participants achieved a knowledge increase significant to the improvement of their professional or personal. Thus, we conclude stressing the importance of digital inclusion initiatives to achieve social inclusion.[1]

Keywords: Digital inclusion, education, information access, information retrieval, spatial analysis.

[1] This work is partially supported by Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG), Governo do Estado de Minas Gerais, Brazil, Rua Raul Pompéia, no101 - São Pedro, Belo Horizonte, MG, 30.330-080, Brazil.

I. Introduction

Considering that digital inclusion is considered a way of generating knowledge, this paper makes a theoretical research and evaluates the performance of a digital inclusion program.

Digital inclusion comprises informational literacy with a focus on information technology, ie, the ability to operate and communicate from computers; understand the operation of the equipment, its programs and applications; produce, organize, manipulate and access information, solve problems through the use of technology, use of computational resources to achieve social inclusion.

This study evaluates the efficiency of the Digital Inclusion Program - PID developed at Universidade Federal de São João del Rei - UFSJ, Campus Alto Paraopeba - CAP, Minas Gerais/Brazil, seeking to identify the insertion vision of methods that make use of them, and how to deployment, planning, methodology and achievements in promoting digital inclusion of community participants.

The Digital Inclusion Program is an initiative to permit the community getting knowledge through the use of computational resources, showing the impact it has on the lives of people.

Was analyzed a group of 153 people who attended the Digital Inclusion Program since its inception in 2008. Participants were selected through a partnership from UFSJ and local governments of Ouro Branco, Congonhas and Conselheiro Lafaiete, in addition to direct contact with assistential entities in community. The criteria used for selection of the participants were surveys of the level of utilization of computing resources and access to information. This process began with the lifting of the parameters motivators for participation and then proceeded to define criteria to measure the performance of the use of computational resources, access to information and use of social networks. Through the teaching of information technologies was promoted professional training and personal development. There was an increase of relations between the academic community and the local community where UFSJ could interconnect their teaching and research activities with the demands of its region. As a byproduct, was designed a geographic information system that contains the spatial locations of assistential entities working in the cities and the questionnaires applied to communities. This system had supported the process of exploring and selecting new participants from the spatial analysis of the digital divide in the city. Finally, we could evaluate the training of local teachers as

multipliers and disseminators of information by technological means.

To make the analysis of program performance, three questionnaires were applied in different times, beginning, middle and end of each group. By means of questionnaires could define the level of knowledge achieved by the participants reaching up to 97% efficacy in performing basic tasks.

Through research we can conclude that digital inclusion covers the use of technological resources to begin or deepen the integration of the individual in the information society. Includes the use of computing resources providing access to information and use of resources efficiently generating knowledge and consequently more personal and professional opportunities for participants.

II. LITERATURE REVIEW

This section of the survey is a survey and discussion of terms that are tangent to digital inclusion and social inclusion and education, access to information; digital divide; policies and information society, and informational competency.

SOCIAL INCLUSION AND EDUCATION

The term inclusion is considered as an established process within a wider society that seeks to satisfy requirements related to quality of life, human development, income autonomy, equal rights and opportunities for individuals and groups that in some stage of their life are at a disadvantage with relation to other members of society [1].

The social education of the population through governmental actions is essential for the development of citizenship, evolution of public management and real implementation of social inclusion. Facilitate social inclusion is the responsibility of the government, and demand from the State quality management required for social development, it is the responsibility of the citizen [2].

Having access to information technology facilitates the retrieval of information and, consequently, new job opportunities, income, quality education and communication , having as rule the potentiation of opportunities in seek and use knowledge. But the availability is not inclusive, because there is the requirement for new skills to have mastery of informational networks. And requires different formation and higher than the industrial era required besides demanding capacity for reflection and synthesis. The challenge for access and inclusion begins with the dependence on technological infrastructure and its sustaining, but, above all, the ability to extract contents from computers and other technical devices, transforming it into knowledge, ie, transformation of information in use [3].

INFORMATION ACCESS

The ability to access and use of information has been consolidated as the most important element in the economic and social development, as well as requisite to citizenship. The goal of democratizing access to information, is to promote the development of the individual, his group and society broadly [4].

The need for dissemination of knowledge, with a view to the common welfare directs studies for understanding the process of knowledge transfer. The information becomes a factor that relates the knowledge with human development, by virtue of the emergence of new technological models [5].

Nowadays, the information becomes newest source of wealth and power. It is the emergence of a new global informational economy made possible by the development of technologies that have transformed the world and by creation of information networks that can bring many benefits [6]. It is within this focus that issues concerning to knowledge and access to information have expressive relevance gain. The big challenge is to promote a proper management that meets the users involved, promoting competitive advantage that can add value, develop and differentiate [7].

The concept of informational appropriation in the sense of capacitation in information technology became popular and indicated the beginning of the processes around the global need of digital inclusion. This new reality shows us the need to prepare both the professional as the individual to appropriate of the instruments of access to information, with an emphasis on communications infrastructure and the acquisition of skills in using computers and the Internet [8].

It is through access to information that the citizen has conditions to know and fulfill their duties as well as understand and claim their rights. Only with information, individuals can contribute, participate and take their place in society, as well as accompany, evaluate and question the actions of the state in order to promote the common good [9].

DIGITAL EXCLUSION

The importance of efforts to combat the digital divide will be determined by the ability to include other forms of inequality. Faced with this increasing complexity, new challenges are presented to formulators of public policies. What is at stake is access, the possibility to navigate the space of flows and interact on information networks. Is the role of the state devote special attention to the incorporation of social groups disadvantaged and low-income to the information society [10].

Digital inclusion, from the point of view of a community means broadening technologies to processes that contribute to the strengthening of its economic activities, their organizational skills, educational level and self-esteem of its members, their communication with other groups, their entities and local services and their quality of life [11].

In all discussion on the digital divide in Brazil, it is widely assumed the fact that people do not use information technology and communication (ITC) due to impediments economic, social, cultural, educational or technological [7].

The information technology and communication (ITC) brings the possibility of democratization and universalisation of information with great potential to decrease social exclusion, although paradoxically it have produced in undeveloped

countries a new type of exclusion, digital. That is, a new social division is placed, those which have monopoly of thought, the transformation of information into knowledge and those who are excluded from this process to be dependent on specific competences [12].

III. METHODOLOGY

In the first stage of the research was carried out the mapping of active assistential communities in Ouro Branco / MG and the lifting of computational resources and access to information in these entities. This mapping was done by means of questionnaires to the community with support of the municipality of Ouro Branco for determining and have access to assistential entities to be researched. Was requested to a digital map of the city and in an environment of GIS, the assistential entities were registered and then generated a database with the information corresponding to each entity. As a result we obtained the Assistential Entities Map of the City of Ouro Branco - MG (Fig. 1). In the enlarged detail of a portion of the map (Fig. 2), the red circles identify the entities and, the inside number correspond to the index in database. After confection the map and database, a questionnaire was designed and applied to all entities in the database. The questionnaire sought to raise the following data: person responsible for entity; administrative information of the entity; profile of persons attended by the entity; infrastructure, qualification, characteristics of special needs persons met.

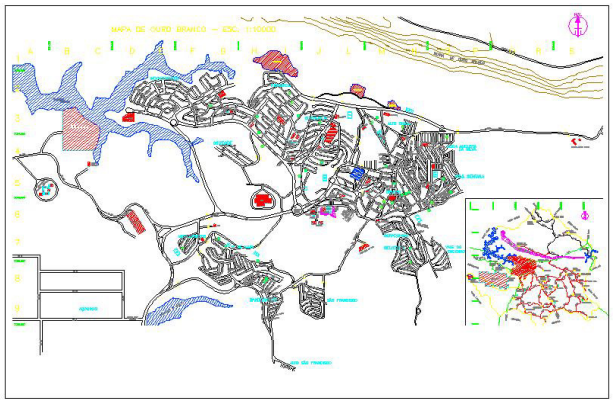


Figure 1. Map of Assistance Entities of Ouro Branco – MG / Brazil

From a spatial analysis of the data was elaborated a thematic map of the digital exclusion the city of Ouro Branco that guided the actions related to the selection of participants to the digital inclusion program of the CAP / UFSJ by defining the assistential entities that would be candidates for participation in the program.

Second questionnaire was drawn up and this was applied to beneficiaries of the selected entities. About the new database was developed a search, according to demand, of potential candidates for the extension program "Digital Inclusion" of Campus Alto Paraopeba/UFSJ.

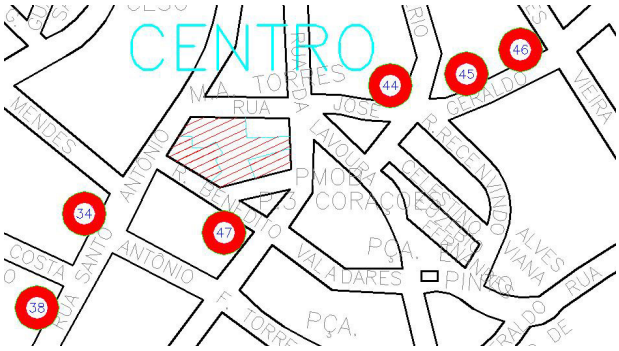


Figure 2. Detail of Map of Assistance Entities of Ouro Branco – MG / Brazil

The second stage of the research constituted of the selection of participants occurred in two ways. One group of participants was selected from the first phase of the research involved the analysis of thematic map and questionnaires applied to communities. Another group of participants was selected through a partnership of UFSJ with the municipalities Ouro Branco, Congonhas and Conselheiro Lafaiete from the Alto Paraopeba region, involving officials of the respective municipalities. This selection was performed by municipalities which applied a questionnaire in order to identify personal characteristics, professional level of computational knowledge and availability of staff. The third stage of the research included monitoring the development of the digital inclusion program by participating in some meetings. We evaluated the focus of activity of the program, defined according to the profile of the group that were established according to the list of candidates and the needs presented. The focus could be: officials from municipalities, public school teachers, seniors, rural residents, high school students, people to be included in the labor market, those seeking job training. Was evaluated the performance of the team and the proposed content for each group. The digital inclusion program was developed for community participation in the meetings at UFSJ computer lab, equipped with 30 (thirty) computers connected to the internet and multimedia projector. The program team was composed of faculty, students (fellow of the extension program and activity UFSJ, interns SIAPE), UFSJ technicians, students and scholars of the Institutional Program of Scientific Initiation Junior (PIBIC Junior / FAPEMIG).

The fourth step was performed by quantitative methods, in which were applied and evaluated three questionnaires at different times of the meetings: beginning, middle and end. The first of these questionnaires addressed the personal and professional characteristics, bearing in consideration the needs and expectations of the participants in the preparation of contents to be developed. Furthermore, other data were collected as education level, place of access to computers; reason for interest and expectations; performance level on the computer, access and frequency of use of information technologies. The second questionnaire assessed the development of activities, participants' perceptions regarding the quality of the teaching material, the capacity of explanation of the instructors, the evaluation about their own learning and possible performance improve at work and in personal life and in the frequency of use of information technology. The third

questionnaire approached the following: quality of teaching materials; explanation capacity of instructors; quality of learning; possible growth in relation to performance on the computer, access and frequency of use of information technologies, possible improves in performance job; possible financial rise; motivation to continue professional training.

The fifth stage of the research was characterized by a qualitative analysis, mainly by non statistical mode of analyze, interpret and present data. Was conducted through interviews aiming to recover the opinion of the participants and obtain a significant set of discursive materials.

Figure 3. UFSJ Participants during one of the meetings in UFSJ

The Digital Inclusion Program Alto Paraopeba began in 2008 through the initiative of a group of teachers from UFSJ as an extension project. Developed in the community of Alto Paraopeba counts with the partnership the municipalities of Ouro Branco, Congonhas and Conselheiro Lafaiete. Currently consists of a teacher´s team of UFSJ and UFMG, extension students, undergraduates and technicians. In 2010, it was contemplated by the Support Program for University Extension of MEC - Ministry of Education and Culture. Until now had the participation of 180 community people. Currently has 60 meetings participants. The program has generated publications with different approaches. The Digital Inclusion Program aims to help community members obtain knowledge in computational resources to use promoting different applications. Participants are selected through questionnaires and communities mappings in the region. Through mapping is done the identification of the regions with higher demand for the program. Another way to selecting is by partnering with the city halls when were selected officials who had personal or professional interest to participate. The questionnaires used in the selection had defined motivators parameters and quantify the use of computational resources of each participant. The meetings are held weekly and each class lasts for one semester.

The participants showed interest in the program, 95% found that computer became learning more interesting, 97% claim that this program served as a motivation to make new professionalizing courses.

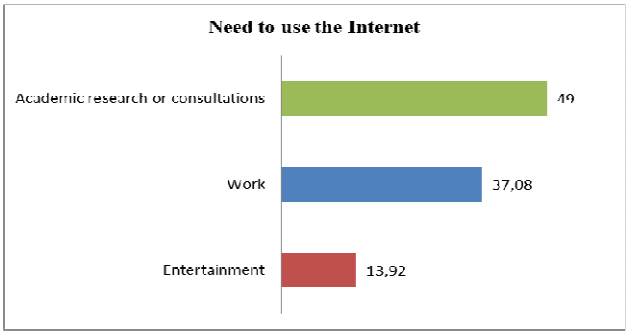
Considering these questionnaires analysis and surveys , is possible to conclude that the program achieves those goals. Baracho (2010) shows in detail the Inclusion Program Alto Paraopeba - MG with methodology and results.

IV. RESULTS

Of the 179 participants who started, 153 completed the program, so the utilization rate was 85%. These 153 people were divided into six class to obtain better monitoring and control during the course.

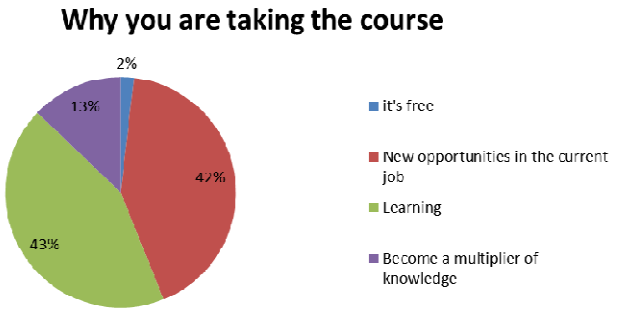
By the methods used, it was possible to make quantitative and qualitative analysis regarding the performance of 153 participants. Through surveys conducted during the course, 77% of participants felt disadvantaged at work because they not knew how access the computer and internet. At the end, 94% of participants claim they have used what they learned and 97% were using the Internet frequently. Then was analyzed for which purposes these people were using the internet.

The Graphic 1 presents these data in detail, by highlighting that 49% of participants use the Internet to do research or academic appointments, seeking to perform certain tasks with greater efficiency and practicality.



Graphic 1 – Need to use the Internet.

Graphic 2 presents the motivators that students had to participate in the "Digital Inclusion Program". According to these data, a significant proportion of participants (43.24%) were has a goal seeking knowledge itself through the use of Technologies. In the sequel, 42.08% of participants sought, by learning technologies, improvements in employment or work. A smaller amount, 12.84% of the participants, sought the course to become knowledge multipliers, p. ex., such as participating in social programs. Finally 1.85% of the course participants sought to be free.



Graphic 2 – Reason for interest in the course

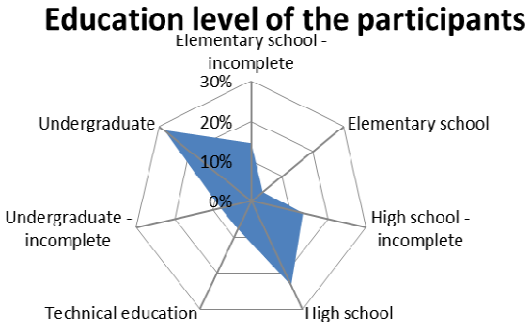
Was realized analyses about schooling of the participants, seeking to demonstrate the degree of heterogeneity that the program intends. Graphic 3 shows the education level of the participants.

This point of the survey, according to data from Graphic 3, shows that the "Digital Inclusion Program" meets various social and professional levels with different foci, highlighting 28.30% of the participants with a college degree and 14.50% with incomplete elementary school.

TABLE 1
Performance on the computer

Activities that can do	*1º Quest %*	*2º Quest %*	*3º Quest %*
Turning on and off the computer	91,76	97,50	100
Create a folder	50,53	95,17	98,63
Move contents to folder	34,99	78,61	98,63
Delete contents of a folder	50,56	76,48	98,33
Open programs	45,54	82,46	98,42
Set date and time	29,45	79,06	88,02
Copy files (cd / pen drive)	28,98	46,57	82,90
Typing and edit text	48,58	85,97	97,67
Create a table	20,87	78,65	93,77
Edit an image	14,83	73,84	92,92
Print a file	47,55	70,26	89,16
Accessing websites	55,51	76,28	96,13
Search content on the Internet	47,8	75,89	97,83
copy content from the internet	27,41	51,53	93,93
Create an e-mail	13,51	38,49	81,08
Access a e-mail	42,75	64,98	92,39
Read, write and send a e-mail	40,17	70,39	88,13
Attach files to an e-mail	18,54	45,60	71,03
Use presentation programs	8,22	52,28	92,91
Create a spreadsheet	4,96	21.47	87,65
Create charts	3,08	18,42	61,87
Using formulas and functions	6,27	16,55	80,53
Formatting Spreadsheet	13,04	14,97	57,62

The data in Table 1 were obtained by applying three questionnaires at different times: at the beginning, middle and end of program. Basic informatics functions were addressed to evaluate the performance of the participants on computer use.



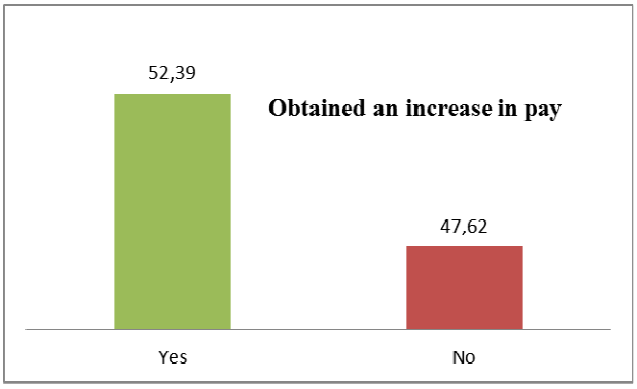
Graphic 3 – Schooling of the participants

According to the proposed methodology, two interviews were realized with the participants. The first, held at the beginning of the course, aimed to analyze the expectations and needs of the students regarding the use of information technologies.

The participant Silvana Maria Lucas Farias, teacher, at begin the course made the following argument: "Being digitally included is able to apply information technologies in life and at work. My expectations about the course is to be a more informed and independent person. I hope to learn computational techniques to work more efficiently". The second interview, applied at the end of the course, have aimed to rescue the opinion and participation of students, making possible recommendations for the best development of the program. The participant Daiana dos Santos, at completing the course, made the following statement: "The course was very good, the topics presented attended all my expectations. Furthermore, this digital inclusion program served as a motivation to do other professionalizing courses. I hope apply the knowledge gained providing a good formation and thus a better future.

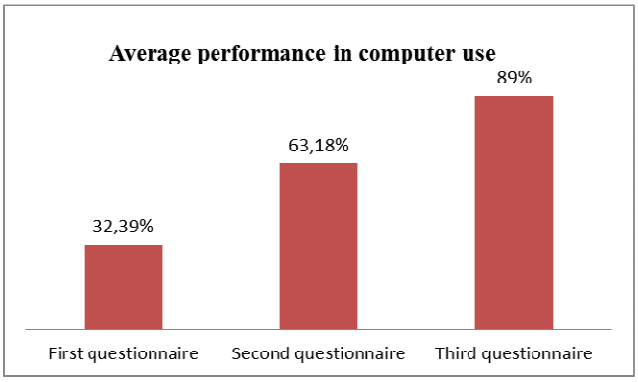
The "Digital Inclusion Program" have promoting professional training and personal development.

The Graphic 4 shows that of the 153 people who participated in the program, 52% claimed to have achieved an increase in pay, applying the knowledge acquired.



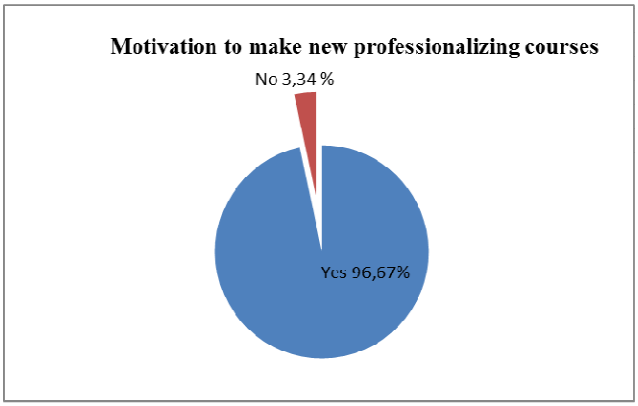
Graphic 4 – Remuneration improving

The Graphic 5 shows the performance of the participants with the average of the questionnaires.



Graphic 5 – Mean performance in computer

According to these data, at the beginning of the program the class could play 32.39% of computer activities. At the end of the process, the evaluation of third questionnaire, the average performance of the computer increased to 89%. This point of the research confirmed the effectiveness of the program.



Graphic 6 – Motivation to make new professionalizing courses.

V. CONCLUSION

Through research we can conclude that digital inclusion covers the use of technological resources to begin or deepen the insertion of the individual in the information society. Includes the use of computational resources propitiating access to information and use of resources efficiently, generating knowledge and, consequently more personal opportunities and professional for participants.

According to the analysis of the results it was possible to concluded that the program has achieved its objectives, meeting the expectations of the participants. It can be affirmed that 100% of participants achieved a significant knowledge in informatics to improve their professional performance or personal. The participants showed interest in the program, 95% found that the computational resources become learning more interesting. 97% claim that this program served as a motivation to make new professionalizing courses (Graphic 6).

The Digital Inclusion Program has great relevance, presents concrete results in order to provide access to information technology to most of the population that does not have those means and not reach individually.

REFERENCES

[1] Passerino, L. M.; Montardo, S. P. *Inclusão social via acessibilidade digital: Proposta de inclusão digital para Pessoas com Necessidades Especiais*. XI Colóquio Internacional sobre a Escola Latino Americana de Comunicação. Universidade Católica de Pelotas, Pelotas, RS, de 7 a 9 de maio de 2007.

[2] Calderon, H. *Inclusão social.* VIII Congreso Internacional del CLAD sobre la Reforma del Estado y de la Administración Pública, Panamá, 28-31 Oct. 2003.

[3] Aun, Marta Pinheiro, Angelo, Edna da Silva. Observatório da Inclusão Digital. In: AUN, M. P.(Coord.) *Observatório da Inclusão Digital: Descrição e avaliação dos indicadores adotados nos programas governamentais de infoinclusão*. Belo Horizonte: Orion, Cap. 2, p. 32-53, 2007.

[4] Barreto, A. A. *As tecnologias intensivas de informação e comunicação e o reposicionamento dos atores do setor*. In: INFO 97, Cuba, outubro de 1997.

[5] Aun, Marta Pinheiro; Câmara, Mauro Araújo. A inserção social através de telecentros: notas de pesquisa. Liinc em Revista, v. 1, n.2, set., p. 148-165, 2005. Disponível em:
<http://www.liinc.ufrj.br/revista>.

[6] Aun, M. P. Sociedade da Informação e a Economia Mundial. In: AUN, Marta Pinheiro. Antiga Nações, Novas Redes: As transformações do processo de construção de políticas de informação. Rio de Janeiro, 2001. Cap. 2. p. 42-68. Tese (Doutorado em Ciência da Informação).

[7] Baracho, R. M. A., Porto, M. F., Soares, M. M. *Inclusão Social: programa de inclusão digital para a comunidade do Alto Paraopeba (MG)*. XI ENANCIB - Tema: Inovação e inclusão social: questões contemporâneas da informação. 2010.

[8] Ferreira, S. M. S. P.; Dudziak, E. A. La alfabetización informacional para la ciudadanía en América Latina: el punto de vista del usuario final de programas nacionales de información y / o inclusión digital. In: *World library and information congress: 70th IFLA General Conference and Council*, 70, 2004, Buenos Aires. Anais Buenos Aires, 2004.

[9] Santos, E. M.; Duarte, E. A.; Prata, N. V. Cidadania e trabalho na sociedade da informação: uma abordagem baseada na competência informacional. *Perspectivas em ciência da informação*, v.13, n.3, p.208-222, set/dez. 2008.

[10] Gomes, M. M. T. *Sem medo de [o]usar: Inclusão digital em campos*, Vértices, vol. 6, no. 3, 2004. Disponível em <http://www.essentiaeditora.iff.edu.br/index.php/vertices/article/view/100>

[11] De Luca, C. *O que é inclusão digital*. In: CRUZ, Renato. O que as Empresas Podem Fazer pela Inclusão Digital. São Paulo: Instituto Ethos, 2004.

[12] Schwarzelmüller, A. F. *Inclusão digital: uma abordagem alternativa*. Departamento de Ciência da Computação da UFBA. 2005.

Sentiment analysis in social networks

Renata Maria Abrantes Baracho, Marcelo Peixoto Bax, Luiz Gustavo Fonseca Ferreira, Gabriel Caíres Silva
School of Information Science
Federal University of Minas Gerais
Belo Horizonte, Brazil
renatabaracho@ufmg.br

Abstract – This paper presents partial results of a research project that aims to create a process of sentiment analysis based on ontologies in the automobile domain and then to develop a prototype. The process aims at making a social media analysis, identifying feelings and opinions about brands and vehicle parts. The method that guided the development process involves the construction of ontologies and a dictionary of terms that reflect the structure of the vocabulary domain. The proposed process is capable of generating information that answers questions such as: "In the opinion of the customer, which car is better: Corsa or Palio? Which one is more beautiful? Which engine is stronger?" To answer these questions by comparison, one can show a general view reflected on different social networks, indicating, for example, that for a given vehicle, a certain percentage of responses are considered positive, while for others, the percentage is considered negative. The results can be used for various purposes such as guiding decisions to improve the products or directing specific marketing strategies. The process can be generalized and applied to other areas in which organizations are interested in monitoring views expressed about their products and services.1 [1]

Information system, information retrieval, web

I. INTRODUCTION

The increase of personal information available on the Web, especially in recent years, is noteworthy at least. With the advent of what is called Web 2.0, countless opinions and feelings about every subject, are wildly available throughout the Web. In this new era, besides the content offered by companies and organizations, individuals have come to share reviews and opinions via personal blogs, networking sites, and microblogs, just to name a few. This paper presents the initial results of a research project whose main objective is to create a model of knowledge representation in the context of social networks on the Web. In this project we developed a prototype software for sentiment analysis of an automobile brand on the Web. This is archived by the use of morphologic analysis, and language features detection aided by ontologies. Specific objectives include the design of methodologies for opinion mining, composition and classification, creation of a dictionary of terms that contains sentiment orientation by translating this type of dictionary from another language, design and use of ontologies to be used in the process of sentiment detection and data summarization and finally the working prototype itself. Our prototype is applied to a specific company in the automobile market (FIAT) and presents innovative nature of monitoring business intelligence and user opinion. It targets information available on the Web from several sources (such as automotive centered portals, blogs and discussion groups) in Portuguese language, although the presented methodology could be easily applied to any other language, source or targeted domain. The objective for the prototype is that it should be able to answer questions and give important insights about the sentiment on car brands on the Web. For example: "what are people saying about FIAT Punto in social media?" These results can be used to improve products or direct marketing strategies, as well as be applied by any other organization interested in monitoring sentiment about a product and/or service.The proposed methodology and our resulting prototype collects, structures and analyzes Web information by using a combination of text processing technologies with several other linguistic techniques such as morphological, syntactic and semantic analysis guided by the target domain terms supplied by our ontologies and the list of terms that evokes sentiment (with a given polarity and strength value) supplied by our sentiment dictionary. The information in our ontology is structured as trees of objects that relate to each other as a is part of or is one relationships. Each object may have one or more terms that can be used to identify references to that particular object on the sentences extracted. Each sentiment detected in the process described is then stored in the ontology tree structure, as a link of one or more objects in the ontology tree to a sentiment value, that can be either neutral, positive or negative. Using this hybrid unsupervised approach, by combining language processing, lexicon techniques and ontology techniques for the sentiment data structure, we expect to generate classifiers for sentiments and opinions and business intelligence insights that improve the results obtained so far in sentiment analysis and opinion mining without relying on supervised algorithms such as machinelearning approaches that requires a costly training phase that may be impeditive for groups with limited resources.This project is funded by the state financing agency. The group is composed of two PhD and two graduate researchers. The project's main area of research is Information and Knowledge Management, but as our main objective is to retrieve information from texts in natural language processing them lexically and morphologically to extract semantic proprieties (sentiments) with the use of ontologies we also relate the areas of Information Extraction and Retrieval, Knowledge Representation, Analysis of Information Systems, Semantic Technology and Philosophy of Information.

[1] This work is partially supported by Fundac¸ ˜ao de Amparo `a Pesquisa do Estado de Minas Gerais (FAPEMIG), Governo do Estado de Minas Gerais, Brazil, Rua Raul Pomp´eia, no101 - S˜ao Pedro, Belo Horizonte, MG, 30.330-080, Brazil.

II. LITERATURE REVIEW

With the rise of Web 2.0 and specialized portals, blogs, and social networks, an enormous amount of new personal opinion is made accessible on a daily basis. Reviews, ratings, recommendations and other forms of expression are available on-line. Information previously obtained through a costly and time consuming process of satisfaction and opinion research can now be obtained on a large scale on the Web. The new challenge is how to process and interpret this massive amount of information, and this challenge is the object of research in the discipline called "sentiment analysis and opinion mining". In this research we consider the following definition for the term "sentiment analysis and opinion mining:" the identification, extraction and study of opinions, feelings and emotions expressed in texts from the web. In the following section, the theoretical framework of the research project can be found. The research papers reviewed below inspired the developments of the method and process of sentiment analysis detailed in Section 3.

[Cicortas et al. 2009] There is a growing demand for information systems-oriented interpretation of human language. These systems are designed to be capable of understanding the intentions and opinions of the author with minimal human intervention. In the article entitled Considerations on Ontologies Construction, the author identifies the challenge the interpretation of heterogeneous information by automated tools and analyzes possibilities of using ontology to resolve these issues. The combination of ontological and natural language rules are seen as a solution to improve performance of sentiment analysis.

Also in this context, the importance of ontologies in identifying the meaning of information, through detailed description of complex systems is highlighted, [Rosner and Kunze 2003]. Also discussions about the best practices for building ontologies. The authors present their experiences related to construction of new ontologies, detailing various methods for the use of language constraints, design principles and ideas for frameworks. They emphasize the importance of having a quality system to detect synonyms in a process of creating ontologies, since its absence in many cases, can compromise the quality of the results.

The paper [Mocha and Tianfag 2010] presents a new methodology to identify the relationship between opinion and reference elements in text passages analysis using "parsing" of dependencies, as well as shallow semantic analysis. This analysis is based on an ontology of words (dictionary) and a collocation database seeking to consider all the semantics behind the topic and sentiment. The parsing algorithm used basically follows four steps: first the identification of the sentence object (nominal subject or direct object or a hidden subject given an adverbial modification, common in Chinese), the second step detects logical relationships between objects (detecting things like hidden features). The last two steps are basically heuristics to identify indirect relationships. In each step, containing fragments identified feelings are being linked with some object tree hierarchical ontology. The results show that the technique can be used in general bases like the corpus public COAE2008.

[Polpinij and Ghose 2008] In an article An Ontology-Based Sentiment Classification Methodology for Online Consumer Reviews, classification is presented as a proposed ontological approach based on lexical variation. The authors propose the use of three sources for the construction of an ontology: a dictionary, a list of text and a set of verbs. From these sources the ontology is built based on three types of information: morphological analysis (indicating a pattern in the composition of the word), a parse (containing information about their classification, e.g. verbs and suffixes such as e.g. and e.s.), and finally a semantic analysis based on logical constraints of synonymy, antonymy and subsumption (relationship "is one").

The ontological structure derived is then used to create a model BOW ("bag of words") and fed into a classifier. According to the authors, this technique achieved satisfactory results, reaching 96% accuracy. [Kunze and R¨osner 2005] present a methodology for ontology extension using concepts derived from a specific domain. The method uses a first and a body ontology partially processed in the domain. The approach is based on syntactic and grammatical structures and basically explores features of the language contained in the input corpus.

[Liu 2010] presents an introduction to key problems and solutions within the existing area of sentiment analysis research highlighting its importance both to individuals and to companies in market research and interest / customer satisfaction. The text provides important definitions such as the concepts of object and features (properties or parts of an object) and opinion (feeling positive, negative or neutral in relation to an object or a feature).

[Wang et al. 2011] propose a method of selection of features for the classification of feelings. Based on linear discriminant analysis (Fisher's discriminant ratio), the method utilizes the concept of information gain (Information Gain) and is validated through the comparison with other methods based on this concept. In the article, the authors present the results of two experiments in which selection methods tested different features. The experimental results indicated that the linear discriminant method has better performance than others.

The approaches used by [Ramanathan and Ramnath 2010] explore the use of context in sentiment analysis using three techniques. The first is an approach that makes use of domain ontology mapping sentences on objects in the ontology. For each object, a weight is defined positive and negative and the positive and negative score of a sentence is defined as the sum of these weights. The weights are defined using machine learning techniques and regression. The second approach makes use of a technique for capturing sequences of characters that appear frequently. For each pair of sentences, extracted a set of words that appear in both, and each of these sets, you assign a score positively or negatively according to how often they appear in sentences. Finally, two approaches are used to combine three techniques for the classification of polarity of a sentence and the results presented.

[Wei and Gulla 2010] present analysis technique based on a tree of feelings of ontological features. The tree SOT (Sentiment Ontology Tree) is constructed to represent the features of an object hierarchy. Each node the tree contains as children. Besides these features there are two leaf nodes

representing the negative and positive feelings of the feature represented by the node. The classification approach used is based on hierarchical classification algorithm. The algorithm takes as input a SOT and texts already sorted and aims to validate the hierarchical construction of sentimental texts. The results demonstrated that knowledge of hierarchical relations improve performance and accuracy of sentiment analysis. In addition, you can use a generic model with a SOT composite, SOT of individual objects, and a root node. This adjustment allows the algorithm to be used with general texts (i.e. not containing a predefined object). [Neviarouskaya et al. 2011] article in The Lexicon for Sentiment Analysis describes a method for automating the generation and marking values for level of feeling subjective text fragments called SentiFul. The idea is to enable any basis to expand through techniques such as direct synonymy, antonym, relations of exploitation, hyponymy derivation, and composition, among others. The proposal is made pursuant to textual recognition, using four types of affixes (used in the derivation of new words), depending on their role with regard to feelings such as propagation, reversal, intensification, and weakening. The derivation is done to find new words using such composition. This process generates a large number of terms useful especially in the case of nouns and adjectives. The algorithm is designed for the automatic extraction of words related to sentiment using terms from WordNet (but using words from SentiFul).

III. METODOLOGY

This section presents the tools and methods that were used in the analysis process of feeling as well as a detailed description of the process developed and proposed in this research.

1 Tools for the process of sentiment analysis: Below the software that makes the PALAVRAS software which performs the semantic analysis of text and was used in the development of the process and the creation of the feelings dictionary is described.

2 The Palavras software: The process developed in the research consisted primarily of semantically analyzing fragments of texts (articles and reviews) of social networks in order to extract information from feelings. To do a semantic analysis of text using WORDS software (developed by Eckhard Bick and based on corpus "Syntactic Forest" of Linguateca) was performed. This is an automatic parser for Portuguese that performs parsing, syntax analysis of the Portuguese language and is able to provide morphological information of a sentence. The process of sentiment analysis prepared by the research begins with the use of WORDS as parser and lexicon. This software is used as the basis of the algorithm, "normalizing" the input and parser. The process of sentiment analysis begins with the extraction of text elements related to the view, then uses the classification of opinion as to his character considered within the scope of positive, negative or neutral. The sequence is performed to compare their opinions and judgments, and commonly uses the term "object" to refer to the target's opinion, which may contain several features or subparts. These may also be subject to reviews.

3. The sentiment dictionary used: The construction of the dictionary of feelings was based on the classification of feelings dictionary Sentistrenght [Thelwall et al. 2012], a dictionary with tens of thousands of terms denoting feelings. The purpose of the dictionary is to quantify feelings. A sample entry in this dictionary would be: "bad: -2", which means that the English word carries a negative feeling with numeric value -2. According to the authors, the dictionary was constructed from research in psychology, philosophy and linguistics. The biggest challenge for the use of the dictionary SentiStrenght during the project was to undertake the translation process while maintaining the real meaning of the words in the English language. The process of translation dictionary Sentistrenght that contains a list of approximately over 22,000 words, through a process of semi-automatic translation, was divided into three steps described below. The first step comprises the initial translation. We used three tools: the Bing Translator from Microsoft, Google and Yahoo BabelFish Translator. From the translation made by each tool, an index of agreement was created. With this it was possible to filter terms with higher disagreement among dictionaries and therefore need more attention. The second step consists in validating the translation of terms. Despite the undoubted utility of translators, automated much texture characteristics of each tongue are not detected, so that often the manual intervention of a person skilled in translation is necessary. As it would be very costly to allocate an expert to translate all the terms in question, it was decided to automate the process. The process consists in the execution of a program designed to access the COMPARA, which is a parallel corpus English/Portuguese available from Linguateca (distributed resource center for the Portuguese language). The operation of COMPARA is as follows: given a term in English (or Portuguese), he shows us how it was the translation of that term in several different contexts, including works of Machado de Assis, Eca de Queiros and Aluisio Azevedo. The program developed at this stage serves as a crawler, referring COMPARA for each of the search terms and registering cases where translations are relevant and where there is no match. Thus, we validate the suggested translation of automated translators from translations made by professionals. The third step was termination. At this stage we select the most relevant terms (i.e., terms that would result in inaccurate translations and have greater negative impact in the search results). With these terms, an inspection was made in each of the translations, looking for imperfections in the translation process done so far. In this step, just under 600 terms were analyzed.

4. Domain-specific ontologies: After defining the analysis of texts and the process of translation dictionaries of terms related to feelings that are considered in the research, we moved to the step of defining ontologies. The concept of ontology was used to guide the process of identifying objects (in this case car models of Fiat and non-FIAT), characteristics (properties of objects such as power, beauty, etc.) , contexts (following paragraphs of opinions on the same object). These are also vital in the final classification. For the development of this research, we used the concept of ontology used in the field of information science as a formal knowledge, a set of concepts, and their relationships in a domain. Ontologies can be used to model human and abstract concepts. The formalization allows

systems to take advantage of human models. Ontologies were created based on models of FIAT. The first ontology of "FIAT models" used in this research adds the necessary information about the Fiat car models. This ontology allows us to not only detect objects of interest in the text (e.g. "Fiat Palio") but also to determine the class that the given object belongs to (a car of the "Hatch" subtype or "Hatch Compact" as shown in Figure 1.

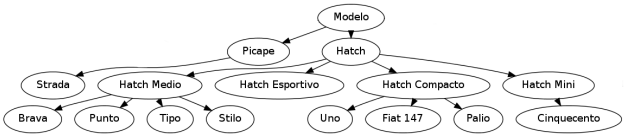


Figure 1. Example of part of the ontology: FIAT Models

The second ontology "Car Features" organizes the relevant features such as an automobile, or adds components and features that are targets of feelings (Figure 2).

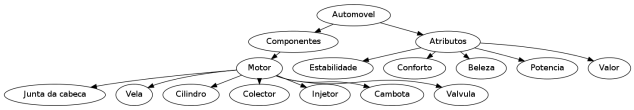


Figure 2. Example of part of the ontology: Features of a car

The third ontology "Non-FIAT Models" is made up of other objects (cars) that have the same features (features and components) of the objects of interest. The features associated with these non-FIAT objects must be detected and correctly excluded from the analysis because it would cause distortion of the result.

5. Complete overview of the analysis process: After the definition of ontologies the process of sentiment analysis proposed was implemented in a prototype. Generally, the process consists in the capture, analysis and storage of opinions. More specifically, the process is divided into eight stages that come from the collection of opinions on social networks to the aggregation of the opinions rendered, as shown in Figure 3. The first steps to represent the views containing the text is captured and standardized. Then the objects of interest (defined by the ontology) are found in the text, as well as their features (characteristics). Subsequently, the detection and the calculation (based on dictionary feelings) of sentiment related to each of the objects of interest and its features are done. Finally, the results are analyzed and stored in forms of reports.

6. Step 1 – Capture: Initially, several blogs themed "cars", which were openly discussed among readers were accessed by a crawler to build the basis of texts (corpus analysis). A funding program was developed to follow accompany the new articles and news sites selected, via RSS (RDF Site Summary). The capture process started by selecting RSS feeds (RSS news aggregator) from sites of interest, such as portals and blogs with the car theme. Then the inner content is extracted and stored as raw XML data and HTML (RSS formats in which are stored on the web). In the second step these raw data are processed by separating the HTML and XML texts of interest to the news and any comments. The result of this step is a collection of texts grouped as news/article (title and text) and the texts of any related comments. This corpus comprises the input for normalization algorithm.

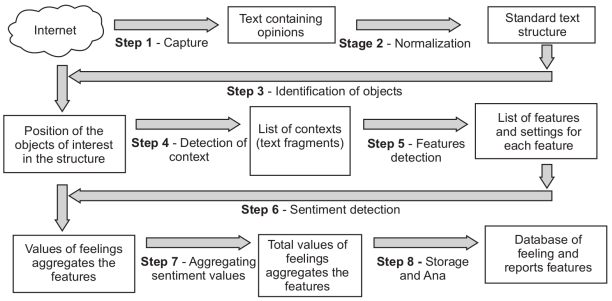


Figure 3. Overview of the review process.

7. Stage 2 – Normalization: After the texts were captured, it was necessary to normalize and prepare themfor algorithm review. In order to this, it is necessary to obtain the morphological and lexical structure of the texts, and bring all terms to their most basic form (infinitive). This step is performed by PALAVRAS software. Below is an example of normalization using the words in a text captured (Figure 4): "I do not know if it's the best, but I am very pleased with my Palio. It is economical and never gave me problems and I have it already since 2003." Text taken from http://br.answers.yahoo.com/question/index?qid=20061112175518AAfs7a3.

não [não] **ADV** @ADVL>
sei [saber] <vt> <fmc> **V** PR 1S IND VFIN @FMV
se [se] **KS** @SUB **@#FS-<ACC**
é [ser] <vK> **V** PR 3S IND VFIN @FMV
o [o] <artd> **DET** M S @>N
melhor [bom] <KOMP> <SUP> <n> **ADJ** M S @<SC
,
mas [mas] **KC** @CO
estou [estar] <vK> <fmc> **V** PR 1S IND VFIN @FMV
muito [muito] <quant> **ADV** @>A
satisfeito [satisfazer] <vt> **V** PCP M S @<SC
com [com] **PRP** @<ADVL
o [o] <artd> **DET** M S @>N
meu [meu] <poss 1S> **DET** M S @>N
pálio [pálio] **N** M S @P<

Figure 4. Normalization output.

8. Step 3 - Identification of objects: Along with the standardized texts, in this step the ontologies of the Fiat brand cars (besides the very word FIAT) and the ontology of brands "Non-FIAT" is used to perform the detection of objects of interest. This step results in the positions of words in texts identified as objects of interest, being the objects of the models identified both FIAT cars (car models identified by Fiat) and non-FIAT (models from other companies) in the texts, we call these positions simply markers of objects that represent the position of words in the text, identified as objects of interest (car models). Recording the positioning is done by counting the number of words required to reach the word object as the beginning of the phrase or the piece of text, that is, the first word reading the text position is zero, the second is a position, and so on. For example, the text is the sentence: "I prefer the Palio, it's strong and has a good internal space. I like the Corsa too, because it's confortable. On the other hand, I never liked Gol.". This text contains an object of interest present in the

FIAT ontology (Palio object) at position 10, and two other objects of the Non-FIAT ontology (the Corsa objects at position 3 and Gol position number 21).

9. Step 4 - Detection of context: The next step consists of extracting the contexts of the objects detected in the previous step. A context, in the proposed process, is represented by a piece of text. Thus, the text of the sentence example of Step 3 is divided into contexts, as illustrated below (Figure 5).

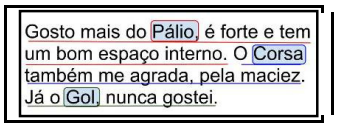


Figure 5. Context detection. "I prefer the Palio, it's strong and has a good internal space. I like the Corsa too, because it's confortable. On the other hand, I never liked Gol."

10. Step 5 - Features detection: Separate contexts, the next step in the detection takes place in the nature or subparts (features) of the car in each of the contexts generated in the previous step. In this case we, use the ontology features of cars (Figure 2) to guide the process (Figure 6).

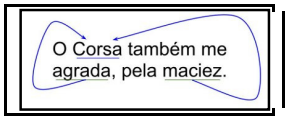


Figure 6. Features detection. eatures detection. Source: Prepared by author

11. Step 6 - Sentiment detection: After detecting the features, the sentiment detection process is carried out. At this stage, SentiStrenght is used to detect and classify the sentiment level. Feelings are related features closer (Figure 7).

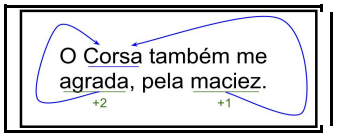


Figure 7. Sentiment detection. Source: Prepared by the author

12. Step 7 - Aggregating sentiment values: Then it is made of an aggregate structure of the detected feelings ontology feature cars (Figure 2). It can therefore be inferred, for example, if somebody speaks well about the power of a car, he/she is referring indirectly to the motor of the car. When checking the feeling at any point on the ontology tree , the feeling values aggregated to the descendants at that point are also recorded for the parent, as well as for all the other points up to it. the feelings of the current point. Therefore a positive feeling about the tires of a car model, is automatically recorded to the car itself reaching the car brand car that gets all the sentiment at the root of the ontology tree.

3.13. Step 8: Storage and Analysis: At this stage of feeling all the information is stored, keeping references to the car model (FIAT ontology), feature (cars ontology) and frameworks for future validations. This allows various types of cross-references and comparisons.

IV. Results

The first result obtained in this project was the construction of the ontology of objects of interest of Fiat cars, the brand researched, the nonFiat objects, and components of cars. These ontologies represent concepts and relationships within the domain of the car market. From these data models can make inferences about the domain objects. Were used both for identifying our target objects, as a bag of words (BOW) initially and latter as a sentiment holder linking objects to sentiments. This allowed the system to measure sentiments at any level of the ontology structure by summarizing the sentiment assigned to descendant objects. Our second result, in a smaller scale, is our sentiment dictionary. Our methodology was successful in translating this type of dictionary from another language without losing too much consistency and meaning while keeping the sentiment strength values. Although some human labor was needed to check the word list coherence most of the process was automatized and could be applied to other languages as well that lacks or have little availability to a proper sentiment dictionary. The proposed methodology to extract, process and analyze sentiments and opinions on theWeb, by using a unsupervised algorithm and the resulting prototype created by implementing this methodology are our third and most important result. When properly loaded with processed sentiment and relationship information, ontology trees can provide a dynamic yet simple way to relate, summarize and visualize processed data (figure 8 shows a visualization created to facilitate the navigation on data). Based on that information, many types of reports can be generated without the need of reprocessing data or sentiments. Comparative studies are a very good example of this concept. With a loaded ontology tree, important questions can be answered such as "Which car is better, based on customer feedback, Corsa or Palio?". The algorithm just needs to summarize every sentiment related to Palio and Corsa, and the decedents. But if the question is 'Which car is considered prettier?", then just sentiments related to each car and its appearance (remembering that appearance is an ontology object defined as part of a vehicle) are used. Many different views on the ontology that answers countless meaningful questions like those on consumer opinions, can be generated. Figure 9 shows our results on the test made partially implementing our methodology that can serve as an example of the report output result that can be obtained from the prototype. Keep in mind that this is a preliminary result, just to exemplify what kind of report can be made using our methodology. This was run as a prof of concept to test if our methodology could process a simple dataset and provide a useful (even if limited) report. We expect much more detailed tests in the following months.

In this particular case (Figure 9 results), opinions were extracted only concerning Corsa, Gol and Palio, which are car brands in direct competition in Brazil. The dataset was obtained from open articles found in social media on the Web mainly constituted by news feeds from many automotive magazines sites, blogs and discussion groups.

Figure 8. Generated data visualization.

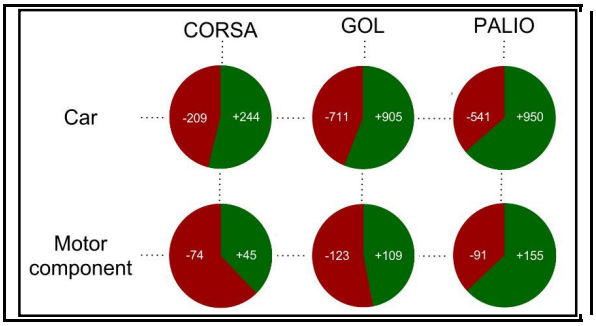


Figure 9. Partial results.

This dataset comprised 8643, articles with 83.571 related comments, for a total of 607.8527 words collected in 53.4846 sentences written by 4.112 authors (combining articles and comments data). Based on the results obtained it can easily be inferred that there are more positive than negative opinions about Palio: 63% of the opinions analyzed were considered positive while 37% were considered negative. For the brand Gol, 47% of the opinions were positive, while 53% were negative. Finally Corsa 38% positive opinions while 62% were negative for the prototype. It can be seen that, while Gol showed a more mixed public opinion result, having almost the same amount of positive and negative opinions, Palio had a more positive public opinion Corse a more negative one. The validation of results for this test run is still ongoing and, since it had to be done by hand, only a very small set of data (only 24 articles and 63 comments) until now. This represents yet a too small validation information to provide meaningful confidence intervals. However in the set already validated we were able to perceive small number of wrong sentiment values or false positive ones (less than 6%) but, a considerably number of false negatives or sentiments not recognized (close to 15%) that we believe can be attributed to the very simplistic and small ontology trees that were used in this first test.

V. CONCLUSION

This paper presented a methodology to process, analyze and summarize sentiments and opinions from sentences extracted from the Web. This methodology was applied to the automotive field for specific analysis of the FIAT brand, resulting in a rototype that is still incomplete, but which could easily be applied to any other domain. Although the practical results were very simple, especially considering the potential for the methodology, it was sufficiently successful to serve as a proofofconcept that the methodology works and can provide interesting insights about the data. Our practical result, on Figure 8 is an illustration of how we can visualize results from the methodology. As our prototype is in its early stages of development this result is just a proof of concept as only a small dataset was processed for just 3 objects of the ontology trees: Corsa, Palio and Gol brands of vehicles. As the development progresses we will be able to show much more detailed insights of much larger datasets. In this particular result, we showed that the Palio brand received a much more positive sentiment value then negative, while Corsa brand received the opposite results and Gol opinions were more mixed. In a recent conference the group was asked about the possibility of changing the process described in Section 3 to make it able to collect information about the author's identity details (sex, age, country) and if the reports could be placed on a timeline, so that analysis could also identify trends. These ideas were noted as possible future developments since it could enrich the scope of the methodology described here. Also as future work we intend to generalize the proposed process so it could be even more easily applied to other areas and organizations interested in monitoring opinions expressed about products and services. A first idea to implement this generalization would be using a SOT tree technique proposed by [Wei and Gulla 2010] in lieu of our simplistic ontology tree.

REFERENCES

[1] Cicortas, A., Iordan, V., and Fortis, A. (2009). Considerations on construction ontologies.CoRR, abs/0905.4601.

[2] Kunze, M. and R¨osner, D. (2005). Context related derivation of word senses. CoRR, abs/cs/0501095.

[3] Liu, B. (2010). Sentiment analysis and subjectivity. Handbook of Natural Language Processing, 2nd ed.

[4] Neviarouskaya, A., Prendinger, H., and Ishizuka, M. (2011). Sentiful: A lexicon for sentiment analysis. IEEE Transactions on Affective Computing, 2:22–36.

[5] Mocha, C. and Tianfang, Y. (2010). Combining dependency parsing with shallow semantic analysis for Chinese opinion-element relation identification.

[6] Polpinij, J. and Ghose, A. K. (2008). An ontology-based sentiment classification methodology for online consumer reviews. In Proceedings of the 2008 IEEE/WIC/ACM International Conference on Web Intelligence and Intelligent Agent Technology – Volume 01, WI-IAT '08, pages 518–524, Washington, DC, USA. IEEE Computer Society.

[7] Ramanathan, J. and Ramnath, R. (2010). Context-assisted sentiment analysis. In The 25th Annual ACM Symposium on Applied Computing, pages 404–413, Sierre, Switzerland. ACM.

[8] R¨osner, D. and Kunze, M. (2003). Exploiting sublanguage and domain characteristics in a bootstrapping approach to lexicon and ontology creation. CoRR, cs.CL/0304035.

[9] Thelwall, M., Buckley, K., and Paltoglou, G. (2012). Sentiment strength detection for the social web. JASIST, 63(1):163–173.

[10] Wang, S., Li, D., Song, X., Wei, Y., and Li, H. (2011). A feature selection method based on improved fisher's discriminant ratio for text sentiment classification. Expert Syst. Appl., 38(7):8696–8702.

[11] Wei, W. and Gulla, J. A. (2010). Sentiment learning on product reviews via sentiment ontology tree. In Proceedings of the 48th Annual Meeting of the Association for Computational Linguistics, ACL '10, pages 404–413, Stroudsburg, PA, USA. Association for Computational Linguistics.

Some Ideas Concerning the Need for Networking of Open Access Repositories of Digital University Libraries: A Case Study of the EU Visegrád Group

Erzsebet Dani

University of Debrecen, Faculty of Informatics, Hungary

dani.erzsebet@inf.unideb.hu

ABSTRACT

For scientific research institutions, as well as for scientists individually, the degree of accessibility of a given institution's and of an individual researcher's scientific achievement is of growing significance in this world of the internet: i.e., it is vitally important to know about and to have easy access to what research is conducted in what fields and with what results in the different institutions. In this study I intend to survey the present situation concerning the homepages of leading universities of the so-called Visegrad Group inside the European Union and the extent to which the present situation serves or fails to serve the cause of the philosophy of open access. My aim is twofold. (1) I will consider whether the scienetific-knowledge repositories built by universities are accessible or not, and/or how easy or difficult it is to access them. Provided that those repositories exist at all, because, in spite of the fact that the Berlin Declaration is generally adopted in principle, the homepages of a good number of the surveyed Visegrad Group universities or libraries do not make their research databases easily accessible or accessible at all, or they can be accessed in the given national language only. (2)

Keywords: case study, European Union, Visegrad Group, universities, visibility, open access repositories, linked homepages.

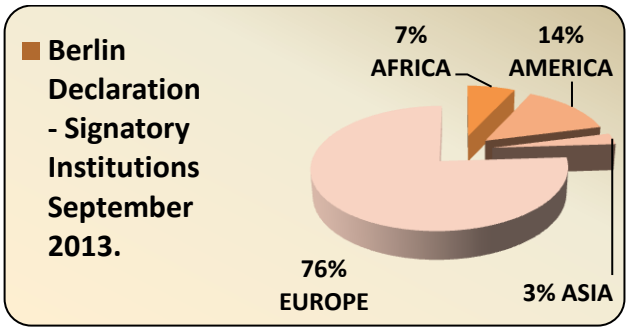
I. THE EU AND OPEN ACCESS

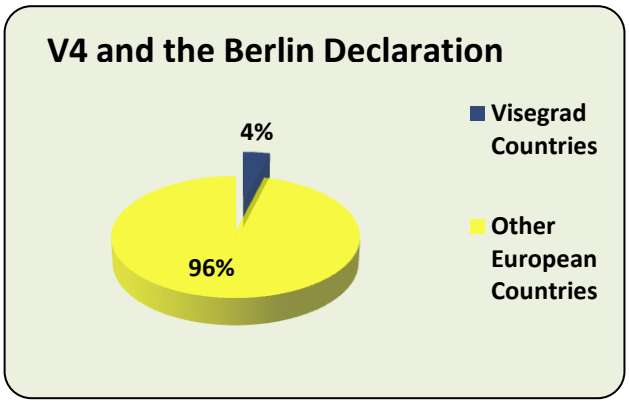
The open access movement was initiated in the field of natural sciences, to facilitate accessibility, among other things, with making free access to research studies and articles as its main concern. At the back of it was the crisis of journals: journal subscriptions were rising to the degree that made financial affordability more and more problematic for universities, research institutions, and libraries. Creating charge-free document archives by developing EPrints software was the next step. Open Archives Initiative (OAI) was launched in 1999, granting full access to metadata; moreover it secures the protocol for simultaneous server-search. In 2000 the Public Library of Science addressed an online petition to publishers, urging them to make their published papers available online. In 2001 the Open Society Institute was set up, and issued its Budapest Open Access Initiative later the same year, thus officially formulating open access for the first time. The 2010 Berlin Declaration shared the same philosophy by assigning a crucial role to internet in making scientific publications accessible and scientific communication possible. More and more universities and research institutes embrace open access philosophy and permit access to scientific documents by building repositories based on self-archiving. There are several well-functioning repositories in Europe (especially in Germany and the United Kingdom).

II. THE BERLIN DECLARATION AND THE VISEGRAD GROUP

340 of the 448 signatory institutions of the Berlin Declaration are European. [1] Of the signers of the so-called Visegrad countries (hence V4) 6 were Czech (University of Economics, Prague, 2012; Association of Libraries of Czech Universities, 2012; MAGNANIMITAS, 2011; Masaryk University, 2010; Czech Science Foundation, 2008; Academy of Sciences of the Czech Republic ,2009); 3 were Hungarian (University of Debrecen, 2009; Hungarian Scientific Research Fund [OTKA], 2008; Central European University, 2003); 3 were Polish (Collegium Artium, 2010; Interdisciplinary Centre for Mathematical and Computational Modelling, University of Warsaw, 2009; Wikimedia Polska

Association, 2007).[1] No signatory institution from Slovakia. [2]





As these data indicate (12 V4 signers out of the 340), the higher education institutions and research institutes of the Visegrad countries do not distinguish themselves in this respect. Only two of the major Hungarian universities (University of Debrecen and Central European University) and one research fund (OTKA) signed the Declaration.

The present research intends to establish to what extent the scientific activity of research institutions is really accessible on the internet in general; also, if open access methodology is in place in the case of the signers of the Berlin Declaration at all? As only few V4 institutions signed the Declaration, the research has been extended to include V4 institutions that did not sign it. This could be the commencing stage of such an investigation, to be followed by further extensions to include larger European regions, and, eventually, all the 28 member countries of the EU. My source for the list of major V4 universities is: http://eu-egyetem.lap.hu/ . [2]

III. ISSUES AND AIMS

Besides raising the issue and surveying the present scene, the contribution of the present study is meant to be the contention that the digital networking of open access digital university libraries would be needed, on the platform of a common language. Attempts to supply answers to the following groups of questions will be adopted as the method of investigation.

-How can it be achieved that researchers of any given institution upload their publications into the institution's repository? How can this requirement be satisfied without compromising copyrights? How are tasks and responsibilities divided between the researcher who uploads the data and the library that builds the database?
-To what extent are existing and continuously expanding databases accessible for researchers of other institutions? After all, if no well-placed link is in sight on a university homepage, to link to the publications-database (which, optimally, is accessible on the university-library homepage), the degree of accessibility is reduced.
-Besides the general methodology of approach, and taking the author's V4 home institution (University of Debrecen, Hungary) as an example, the question will be posed: what is the degree of accessibility of the DEA repository, one with a relatively excellent level of uploading, from the university homepages of other V4 universities? Which is (also) as much as to ask: to what extent is that repository accessible for the universal community of science? Are there links on other V4 university homepages pointing to DEA and vice versa?
-The issue relating to the common language of the digital library depositaries of V4 universities will also be raised.

Finally, the author proposes a 3D link-combination, to facilitate an easy and mutual access of the involved repositories with the least possible number of clicks.

IV. THE V4 COUNTRIES AND THEIR UNIVERSITIES

The Visegrad Cooperation was created in 1991as a means of forming a common economic, diplomatic, and political platform for representing the interests of those four countries (the Czech Republic, Hungary, Poland, and Slovakia). These Central European countries have 28 universities in operation (enlisted by the source mentioned above—but the actual number is, in fact, much higher). In what

[1] 2013data.
[2] [15.06.2013] only the main page

follows, the quality of the individual English-language homepages will be examined; also the accessibility of the library from a given homepage. Does the library have a functional homepage in English? Does the institution have a publications database (repository) of its own? [3]

The Czech Republic

ACADEMY OF FINE ARTS IN PRAGUE (http://www.avu.cz/); only the main page works in English (http://www.avu.cz/english), with minimal information. Practically no information that matters is available in English.

BRNO UNIVERSITY OF TECHNOLOGY (http://www.vutbr.cz/) has a homepage that functions well in English (http://www.vutbr.cz/en/), and the university library is easily accessible through a link, which is distinctly in view. The library's homepage works satisfactorily in English; open access (http://www.vutbr.cz/en/uk/eir/open-access) is indicated, but there is no full-value content behind it: DSpace search field works superbly, the abstracts of the matches found are available in both Czech and English, but the the full-text version is not always there.

CZECH UNIVERSITY OF AGRICULTURE IN PRAGUE (http://www.czu.cz/cs/), with an English version that works fine (http://www.czu.cz/en/). It is difficult to access the library homepage, though (http://infozdroje.sic.czu.cz/en/), and open access is available only in Czech, and registration is needed.

JANÁCEK ACADEMY OF MUSIC AND PERFORMING ARTS (http://www.jamu.cz/); not available in English.

MASARYK UNIVERSITY IN BRNO (http://www.muni.cz/?lang=cs); available in English (http://www.muni.cz/?lang=en), in good operating condition. But it is difficult to find the library – the various faculties have separate libraries of their own, and there is no joint search-surface. No open access in sight at all.

UNIVERSITY OF ECONOMICS IN PRAGUE (http://www.vse.cz/); its English version (http://www.vse.cz/english/) works perfectly well. There is no university publications-database among the library's (http://ciks.vse.cz/Default-en.aspx) services.

Poland

ACADEMY OF FINE ARTS, CRACOW (http://asp.krakow.pl/index.php/pl/strona-glowna); the English version (http://asp.krakow.pl/index.php/en/strona-glowna) provides no information of merit behind the headings. It is troublesome to reach the library homepage (http://bg.asp.krakow.pl/bg/), and it operates in Polish only.

ACADEMY OF FINE ARTS, WROCLAW (http://www.asp.wroc.pl/index.php) ; it has no English version.

ACADEMY OF MUSIC, CRACOW (http://amuz.krakow.pl/); functions well in English (http://www.amuz.krakow.pl/en/29/2/7/History). It offers no link to the library.

ACADEMY OF MUSIC, WARSAW (http://www.chopin.edu.pl/pl/) bears the name of Frederic Chopin; it has an English version (http://www.chopin.edu.pl/en/). It is a high-standard homepage, but has no link to the library.

CRACOW UNIVERSITY OF TECHNOLOGY (http://www.pk.edu.pl/); it is available in English (http://www.en.pk.edu.pl/). Its library homepage (http://www.biblos.pk.edu.pl/) contains a CUT Repository link, with the following quotation on its open access page: *"An old tradition and a new technology have converged to make possible an unprecented public good. The old tradition is the willingness of scientists and scholars to publish the fruits of their research in scholary journals without payment, for the sake of inquiry and knowledge".* [Budapest Open Access Initiative, 2002]

JAGELLONIAN UNIVERSITY, CRACOW (http://www.uj.edu.pl/); it works fairly well in English (http://www.uj.edu.pl/en_GB/), but it tends to switch to Polish amidst a search in progress. The author did not find a link to the library, and there is no repository.

MEDICAL UNIVERSITY OF LODZ (http://www.umed.pl/pl/); its English-language homepage (http://www.umed.pl/eng/) works fine, it makes all important information available. It links to the library easily, but the library homepage is available in Polish only.

MEDICAL UNIVERSITY OF WARSAW (http://www.wum.edu.pl/); its English version is cumbersome (http://www.wum.edu.pl/en), with mixed-language content. The author found no link to the library.

WARSAW SCHOOL OF ECONOMICS (http://www.sgh.waw.pl/index.html); its English homepage (http://www.sgh.waw.pl/index_en.html) works very well. Its library link is distinctly in sight (http://www.sgh.waw.pl/ogolnouczelniane/library/informacje_ogolne-en?set_language=en) , and works fine in English. It provides a "Distributed Catalogue

of Polish Libraries" link, which makes simultaneous search in all of Poland's libraries possible.

WARSAW UNIVERSITY has a homepage (http://www.uw.edu.pl/) which operates well in English (http://www.uw.edu.pl/en/). Its library homepage can be accessed with the help of a search box only (http://www.buw.uw.edu.pl/en/) – no repository.

Hungary

CORVINUS UNIVERSITY of Budapest (http://www.uni-corvinus.hu/index.php?id=35058), has an English-language homepage (http://portal.uni-corvinus.hu/?id=44509), and it works perfectly well. Its link to the library (http://portal.uni-corvinus.hu/index.php?id=44529) is easy to find, an institutional repository is in place, easily accessible; the totality of the services offered can be used in English too. ("Corvius Research Archive")

BUDAPEST UNIVERSITY OF TECHNOLOGY AND ECONOMICS (http://www.bme.hu/); its English homepage (http://www.bme.hu/?language=en) works well. The link to the library can be found easily, but it works only in Hungarian (http://www.omikk.bme.hu/). Under the E-services there are no available data about repository.

UNIVERSTY OF DEBRECEN (http://unideb.hu/portal/); available in English (http://unideb.hu/portal/en), works fine, although the content is often in Hungarian behind a tab. It is difficult to find the link to the library – 3 cliks (http://www.lib.unideb.hu/en) – DEA and UD Publication Database are easily available under Information Resources.

EÖTVÖS LORÁND UNIVERSITY, Budapest. Its homepage (http://www.elte.hu/); works very well in English (http://www.elte.hu/en). The author found no link to the university library. The university has no central library. The joint homepage of the faculty libraries works well in English (http://konyvtar.elte.hu/en/node/971-), but contains no repository.

UNIVERSITY OF KAPOSVÁR (http://www.ke.hu/); its English homepage (http://english.ke.hu/) aims at completeness, but its link to the library is hard to find and contains one static page only.

CENTRAL EUROPEAN UNIVERSITY (http://www.ceu.hu/hu/kee); its English homepage works perfectly well (http://www.ceu.hu/). The link to the library is distinctly in view, clear, logical. The library's English homepage (http://www.library.ceu.hu/cat/#&panel1-1) contains the ETD Collections repository.

UNIVERSITY OF PÉCS (http://www.pte.hu/); its English homepage (http://english.pte.hu/) functions fine, accommodating the library, but in Hungarian only.

UNIVERSITY OF PANNONIA (http://www.uni-pannon.hu/); its English homepage (http://englishweb.uni-pannon.hu/) is tight-lipped, with little information that counts. No link to the library.

Slovakia

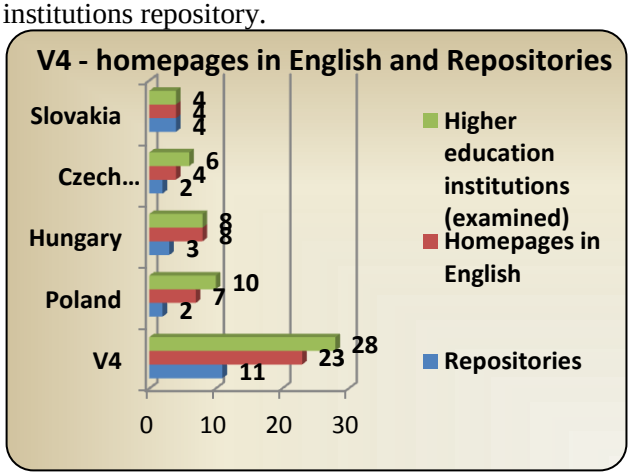
COMENIUS UNIVERSITY IN BRATISLAVA (http://www.uniba.sk/index.php?id=965); its English homepage (http://www.uniba.sk/index.php?id=921) works fine, but contains scarce information on its simple surface. The link to the library can be easily found, but its homepage (http://www.uniba.sk/index.php?id=2156) provides only minimal information regarding the library and the services it offers. But there is a link, on the right-hand side, to the university repository (DB of publication activities).

CONSTANTINE THE PHILOSOPHER UNIVERISTY, NITRA (https://www.ukf.sk/); its English homepage (http://www.en.ukf.sk/) functions adequately. The repository can be found under the Research tab. Only the bibliographical data of the research contributions are provided, with no full texts behind them. It is not difficult to find the link to the library, but it does not work in English, and the menu (full of abbreviations and, perhaps, mixed-language) is very confusing.

SLOVAK UNIVERSITY OF AGRICULTURE (http://www.uniag.sk/sk/); the English homepage (http://www.uniag.sk/en/) works very well. It includes no link to the library, but there is a Publications tab under Science and Research, from which the university repository can be accessed (with full texts also available, unless the publication dates back to earlier than 1950).

UNIVERSITY OF ECONOMICS IN BRATISLAVA (http://www.euba.sk/?lang=sk); homepage works well in English (http://www.euba.sk/?lang=en); links to several universities and organizations appear on the main page in the form of moving links, with high visibility (probably all of them close partner insitutions of the university). The link to the library is also allotted privileged position

(http://193.87.31.4/arl-eu/en/search/), leading straight on to the library's OPAC. Outputs Publications Activities EU comprises the institutions repository.



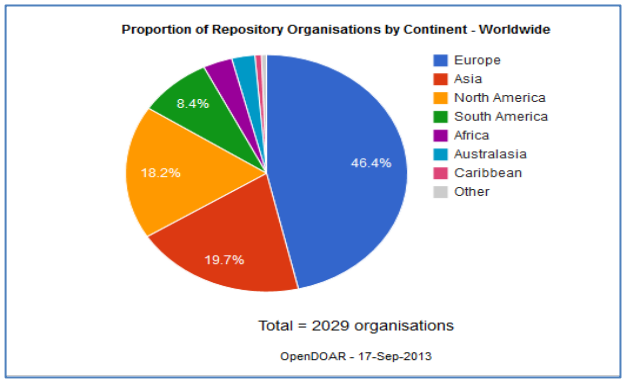
All in all, it is safe to say that the first priority should be the good working condition of English-language homepages. As long as this issue is not taken care of, no networking of V4 science repositories would yield good results. The language of international communication in the 21st century is English. Most of the universities examined here do have English homepages, but very few of them operate it with an aim at totality of services. The second priority would be building institutional repositories in accord with the directives of the Berlin Declaration. Where there is one already in place, further refinement of the details would be necessary; and the university leadership should launch the repository project where there is none yet. Institutional libraries are suitable for the purpose. The third step should be to develop a link-combination of 3D-capability which would combine all V4 institutions into one single virtual network, through which the repository of any university could be reached with a fews clicks. It would serve the purpose if these databases would be collected in a single, joint search surface in the future, so that one could conduct searches in all of them at one and the same time. Fourthly, each and every involved university should post on its homepage (centrally positioned, easy to sight) a link to this link-collection.

The author checked the Hungarian consortium HUNOR (HUNgarian Open Repositories), a joint project of Hungarian higher education institutions and the Library of the Hungarian Academy of Sciences to see what members it had. HUNOR set itself the goal to put open access in practice and to coordinate it in that country. It is their intention (among other things) to put in place a nation-wide infrastructural network for open-access repositories as well as to foster international networking. HUNOR also defines itself as a centre for methodology that also coordinates international linkages. HUNOR could become one of the important network nodes since it is a V4 network near completion. The author deems it most important, for the sake of "visibility," to develop the 3D link-collection that would make accessing repositories from university homepages much easier. Members of HUNOR at present are: Corvinus University of Budapest, Budapest University of Technology and Economics, Central European University, University of Debrecen, Eötvös Loránd University, Eszterházy Károly College, University of Kaposvár, Károli Gáspár University of the Reformed Church in Hungary, Károly Róbert College, Franz Liszt Academy of Music, Hungarian Academy of Sciences, University of Miskolc, Moholy-Nagy University of Art and Design, University of West Hungary, University of Pannonia, Pázmány Péter Catholic University, University of Pécs, Semmelweis University, Széchenyi István University, University of Szeged, Szent István University, University of Theatre and Film Arts, Zrínyi Miklós National Defence University (23 institutions).

As can be seen, 22 higher education institutions and the Academy of Sciences participate in this project while only two universities and the Academy signed the Berlin Declaration. The website that I used as my resource (http://eu-egyetem.lap.hu/) for a starting point, lists only 8 of these institutions. On the other hand, while OpenDOAR[3] also specifies 8 Hungarian institutions with 9 repositories, these include institutions that are not listed by http://eu-egyetem.lap.hu/; they are: Central European University, Corvinus University of Budapest, Hungarian Academy of Sciences (with 2 repositories), National Széchényi Library, Szent István University, University and National Library of the University of Debrecen, University of Miskolc, University of Szeged. [4]

According to the 2013 University of Nottingham data Hungary has 10, the Czech Republic 7, Poland 68 (!) institutions with repositories. There are no data related to Slovakia. It is also relevant that, in intercontinental comparison, Europe takes the leading role in this respect with its share of 49%. [5]

[3] Directory of Open Access Repositories



V. POSSIBLE ANSWERS AND A POSSIBLE MODEL

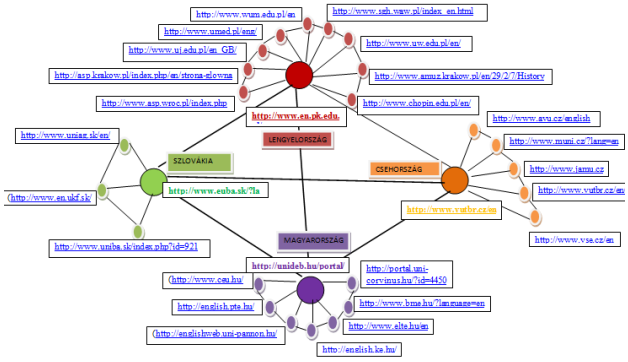
One of the significant points Albert-László Barabási's scale-freee network theory makes is that the measure of accessibility in networks is distance. Any given document on the web is at 19 click's distance from any other. [6] Having now seen where the relevant universities are in relation to the issues raised early in this paper, and taking Barabási's 19-clicks theory into consideration, this study will be concluded with some thoughts concerning those main issues, and a possible way to realize the proposed project will also follow.

-It must be a university-leadership level decision that research faculty upload their publications into the repository which is managed by the library. A presidential decision requires it at the University of Debrecen. Compromising copyrights can be avoided by the manner in which the publications are made public. It means that if a faculty does not consent to making his or her full text publicly available, only the bibliographical data will come into view for the visitor of the database, and permission will be needed to access the full text stored in the repository. The bibliographical data of the publications uploaded into the database by the research faculty will be controlled and corrected by professional librarians—any given study can make its way into the repository through such screening.

-In the course of the present research it was found that the existing databases are not "visible" for the other institutions. Moreover, the route to them is often complicated, difficult. Therefore, the next (also presidential level) decision could be that the webmasters of the university place a clearly seeable link on the university homepage to the library database. That link should be positioned (in a preregulated fashion) to be in the same place and with the same eye-catching technology on every participating institution's homepage. This would greatly enhance the degree of accessibility.

-But one should sweep before one's own door, so let the author return to her home institution for one moment. The open-access repository built by the University and National Library of Debrecen (DEA) works well, its level of uploadedness is outstanding in the examined region, but it does not take us far if no link to the database can be found. Nor are links to other universities found on the university's main page.

-The possible model the author wishes to suggest to realize the big project proposed in this paper could be the network in the figure below. Jumping on towards other universities from any V4 university, any other university's repository could be reached with only a few clicks (the number of clicks depending on the length of the route). In order to reach this stage, the problems outlined in the foregoing three paragraphs must be solved.



References

[1] http://oa.mpg.de/lang/en-uk/berlin-prozess/signatoren/ [09.18.2013.]

[2] http://openaccess.mpg.de/286432/Berlin-Declaration [09.18.2013.]

[3] **Visegrádi Együttműködés** http://www.nfu.hu/visegradi_egyuttmukodes [09.28.2013.]

[4] http://www.opendoar.org/countrylist.php?cContinent=Europe#Hungary [09.28.2013.]

[5] http://www.opendoar.org/find.php?format=charts [10.02.2013]

[6] Barabási A., **Behálózva**: **a hálózatok új tudománya,** Helikon, [Budapest], pp. 41-42.

This research is supported by the European Union. It is funded by EU-project " TÁMOP-4.2.2.C-11/1/KONV-2012-0001" and co-funded by the European Social Fund.

A Data Explorer System and Rulesets of Table Functions

Kunihiko KANEKO[a*], Ashir AHMED[b*], Seddiq ALABBASI[c*]

[*]Department of Advanced Information Technology, Kyushu University,

Motooka 744, Fukuoka-Shi, 819-0395, Japan

[a]E-mail address: kaneko@ait.kyushu-u.ac.jp

[b]E-mail address: ashir@ait.kyushu-u.ac.jp

[c]E-mail address: seddiq@f.ait.kyushu-u.ac.jp

ABSTRACT

In this paper, we present a data analysis and visualization system named "Data Explorer". The system read a data table, and produce analysis and visualization results interactively. The system include many types of table functions. There are different numbers and types of options for each table function. A problem to be tackled is the difficulty to set option values of the table functions. There will be many user mistakes in the option values. To solve the problem, we propose a rule set to decide a candidate set of the option values of the table functions. Here, the data-description data (i.e. metadata) of data table is employed to decide the candidate set. We use the metadata to decide the applicability of table functions, also. The feasibility of the idea is evaluated using two types of dataset. They are iris and the hospital dataset.

Keywords: data analysis, visualization, relational database, metadata.

1. INTRODUCTION

Recently, more and more data are collected. They may be measurement data from sensors. They may be collected using Web forms. If all elements of a dataset are data records (i.e. a data element is a list of fields and each field has an attribute name) of the same record type, the dataset is a data table. If there are many types of records, there will be a different kinds of data table.

2. DATA ANALYSIS AND VISUALIZATION

A data table is a set of data records. Figure 1 depicts an example of data table of the Edgar Anderson's Iris dataset[1]. The dataset is the measurement values of the sepal length, sepal width, petal length, petal width, respectively, for 50 flowers from each of three species of iris. The line added on the top of the data table is called header. A header is the list of attribute names of a data table. In figure 1, there are five attribute names. They are (*Sepal_Length*, *Sepal_Width*, *Petal_Length*, *Petal_Width*, *Species*). Each row of data table is a data record. In figure 1, each data record consists of measurement values and species name.

Given one data table, we can define several types of table functions described below.

- **Table operation**

Table operations from *X* to *Y* will produce a new data table *Y* from a data table *X*. The numbers of rows and columns of *Y* are same as *X*. The record type of each row of *Y* is equal to the record type of each row of *X*. The attribute names of *Y* may different from *X*.

- **Analysis function**

Analysis functions will produce a new data table *Y* from a data table *X*. The record type of each line of *Y* is not equal to the record type of *X*. The attribute names of *Y* may different from *X*.

- **Displaying function**

Displaying functions will display a result using a data table.

The R system[2] is an open-source and free software for statistical analysis and visualization. There are more-than 2,000 packages for the R system. The packages include many types of table functions.

We implemented our data explorer system using the R system. Fig. 2 depicts the data explorer system. In the system, there is one chain from the source data to the final result, and the results are provided to the end-users using displaying functions. The internal nodes of the chains are intermediate results. The final result can be represented using the an expression as below:

$$op_n(op_{n-1}(\ldots op_1(X, \langle option\ values \rangle)\ldots))$$

Here, X is the source data table, and op_i represents a table operation or an analysis function. Table 1 depicts an implementation of table function using the R system. The input of table functions contains one data table, and contains optionally attribute name as string value, and other numeric value or condition expression. Fig. 3 and Fig. 4 depict examples of the table functions.

	Sepal_Length	Sepal_Width	Petal_Length	Petal_Width	Species
1	5.1	3.5	1.4	0.2	"setosa"
2	4.9	3	1.4	0.2	"setosa"
3	4.7	3.2	1.3	0.2	"setosa"
4	4.6	3.1	1.5	0.2	"setosa"
5	5	3.6	1.4	0.2	"setosa"
6	5.4	3.9	1.7	0.4	"setosa"

header

data table

Fig. 1: Data table example. This illustrates the header and top 6 lines of the Edgar Anderson's Iris dataset[1].

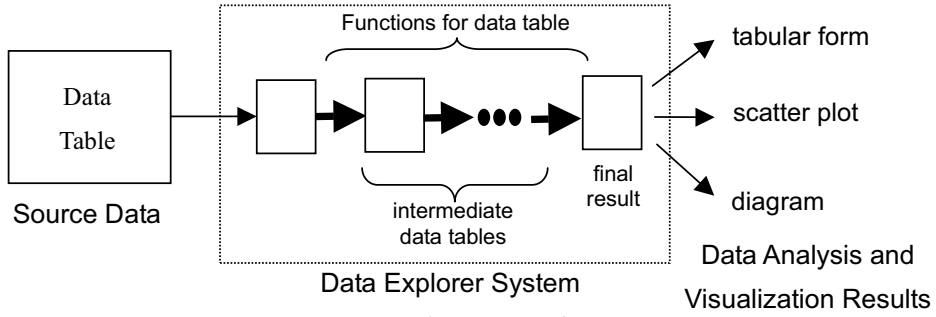


Fig. 2: Data Explorer

Table 1: Data Operations. The variable **X** is data table. The variables **A**, $\mathbf{A_i}$, $\mathbf{A_j}$ and $\mathbf{A_k}$ are attribute names. The variable **Alist** is a list of attribute names. The variable **cond** is a condition expression.

(a) Table operations

Function	Function name and parameters	R system implementation (R source code)

Principle component analysis (PCA)	**pca(X)**	`library(stringr)`
		`pc <- princomp(X, cor=TRUE)`
		`Y <- as.data.frame(data.matrix(X) %*% unclass(loadings(pc)))`
		`names(Y) <- str_replace_all(names(Y),"[.]","_")`

(b) Analysis functions

Function	Function name and parameters	R system implementation (R source code)
Selection of rows	**selection(X,Alist)**	`sqldf(paste("select",Alist,"from X;"))`
Projection of columns	**projection(X,cond)**	`sqldf(paste("select * from X where ",cond,";"))`
Frequency table	**frequency(X,A)**	`R <- sqldf(paste("select",A,"from X;"))` `data.frame(table(R))`
Cross table	**cross_table(X,A_i,A_j)**	`R <- sqldf(paste("select",Ai,",",Aj," from X;"))` `return(table(R))`

(c) Displaying functions

Function	Function name and parameters	R system implementation (R source code)
Display first part	**head(X,lines)**	`head(X, n=lines)`

Two-dimensional scatter plot	**plot2d(X,A_i,A_j)**	`library(ggplot2)`
		`R <- sqldf(paste("select",Ai,"as x,",Aj,"as y from X;"))`
		`ggplot(R, aes(x=x, y=y)) + geom_point + xlab(Ai) + ylab(Aj)`

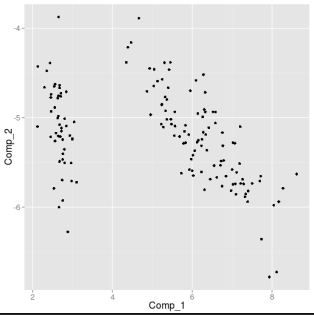
Three-dimensional scatter plot	**plot3d(X,A_i,A_j,A_k)**	`library(scatterplot3d)`
		`R <- sqldf(paste("select",Ai,"as x,",Aj,"as y,",Ak,"as z from X;"))`
		`scatterplot3d(R)`

histogram	**histogram(X, A)**	`R <- sqldf(paste("select",A,"from X;"))` `hist(as.matrix(R))`

Two-fimensional histogram	**histogram2d(X,Ai,Aj,n)**	`library(gregmisc)`
		`R <- sqldf(paste("select",Ai,"as x,",Aj,"as y from X;"))`
		`h <- hist2d(x=R$x,y=R$y,nbins=c(n,n))`
		`persp(h$x,h$y,h$counts,shade=0.2)`

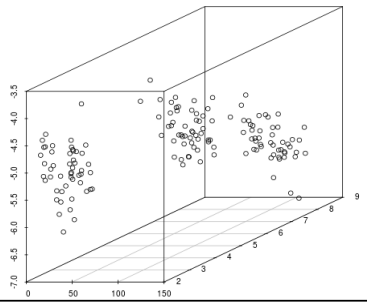
Cluster dendrogram	**cluster(X,m)**	`plot(hclust(dist(X), method=m))`
Gaussian Mixture Model (GMM) classification	**GMM_classification(X,Ai,Aj)**	`R <- sqldf(paste("select",Ai,",",Aj,"from X;"))` `plot(Mclust(R), what="classification"))`

Conditional Inference Tree	**plot_ctree(X,A)**	`library(party)`
		`ct<-ctree(formula(paste(A," ~ .")),data=X)`
		`plot(ct)`



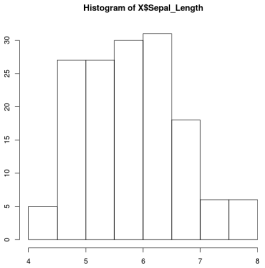

```
plot2d(pca(projection(iris,
"Sepal_Length, Sepal_Width,
Petal_Length, Petal_Width")),"Comp_1",
"Comp_2")
```

(a) Two-dimensional plot of PCA



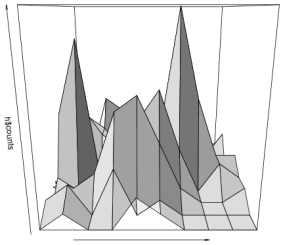
```
plot3d(pca(projection(iris,
"Sepal_Length, Sepal_Width,
Petal_Length, Petal_Width")),"Comp_1",
"Comp_2", "Comp_3")
```

(b) Three-dimensional plot of PCA



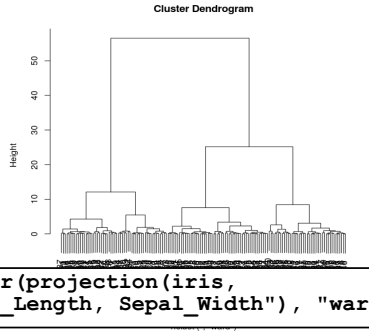

```
histogram(iris, "Sepal_Length")
```

(c) histogram



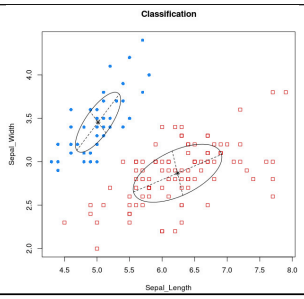
```
histogram2d(iris, "Sepal_Length",
"Sepal_Width", 10)
```

(d) Two-dimensional histogram



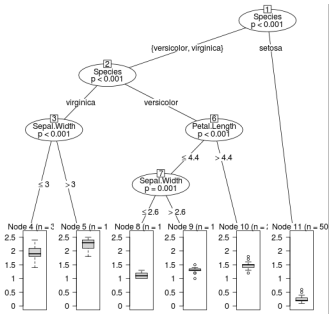

```
cluster(projection(iris,
"Sepal_Length, Sepal_Width"), "ward")
```

(e) cluster dendrogram produced by the ward clustering[3]




```
GMM_classification(iris,
"Sepal_Length", "Sepal_Width"))
```

(f) Gaussian Mixture Model (GMM) classification




```
plot_ctree(iris, "Petal_Width")
```

(g) Conditional Inference Tree

Fig. 3: Commands by Users and Results produced by the Data Explorer. The variable **iris** is the Edgar Anderson's Iris dataset.

	Sepal_Length	Sepal_Width	Petal_Length	Petal_Width	Species
1	5.1	3.5	1.4	0.2	"setosa"
2	4.9	3	1.4	0.2	"setosa"
3	4.7	3.2	1.3	0.2	"setosa"
4	4.6	3.1	1.5	0.2	"setosa"
5	5	3.6	1.4	0.2	"setosa"
6	5.4	3.9	1.7	0.4	"setosa"

(a) Selection of rows: **`head(selection(iris, "Species='¥"setosa¥"'"),n=6)`**

	Sepal_Length	Sepal_Width	Petal_Length	Petal_Width
1	5.1	3.5	1.4	0.2
2	4.9	3	1.4	0.2
3	4.7	3.2	1.3	0.2
4	4.6	3.1	1.5	0.2
5	5	3.6	1.4	0.2
6	5.4	3.9	1.7	0.4

(b) Projection of columns: **`head(projection(iris, "Sepal_Length, Sepal_Width, Petal_Length, Petal_Width"),n=6)`**

	R	Freq
1	"setosa"	50
2	"versicolor"	50
3	"virginica"	50

(c) Frequency table: **`head(frequency(iris,"Sepal_Length"),n=6)`**

	row.names	2	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3
1	4.3	0	0	0	0	0	0	0	0	0	1
2	4.4	0	0	0	0	0	0	0	0	1	1
3	4.5	0	0	1	0	0	0	0	0	0	0
4	4.6	0	0	0	0	0	0	0	0	0	0
5	4.7	0	0	0	0	0	0	0	0	0	0
6	4.8	0	0	0	0	0	0	0	0	0	0

(d) Cross table: **`head(frequency(iris,"Sepal_Length","Sepal_Width"),n=6)`**

Fig. 4: Analysis Function Examples. The variable **`iris`** is the Edgar Anderson's Iris dataset.

3. PROBLEM DEFINITION AND IMPLEMENTATION DETAILS

3.1 Relational Database Interface

The data explorer system read a table from a relational database system. We employee the SQLite3 relational database management system to manage relational database. The source code to open SQLite3 database named **`mydb`** from R system is below.

```
library(RSQLite)
drv <- dbDriver("SQLite", max.con = 1)
conn <- dbConnect(drv, dbname="mydb")
```

The source code to read a table named **`T`** from the database to the variable **`X`** in R system is below.

```
c <- dbSendQuery(conn, "SELECT * from T;")
X <- fetch(c, n=-1)
```

3.2 Metadata

Metadata is a data table that stores the information about record types. For example, the iris dataset has one record type, and the record has five attributes. Table 2 depicts the metadata of the Edgar Anderson's Iris dataset. The attribute *name* is string valued. The attribute *type* may have a value in the set {`integer`, `real`, `text`, `boolean`, `date`, `time`, `datetime`}. The attribute *is_ordered* is either `TRUE` or `FALSE`. If the value of *type* is `integer`, `real`, `date`, `time` or `datetime`, then the value of *is_ordered* is `TRUE`. If the value of *type* is `text` and the text value represents an order (for example "A", "B", "C", and "D"), then the value of *is_ordered* is `TRUE`. Otherwise the value of *is_ordered* is `FALSE`. The attribute *is_categorical* is either `TRUE` or `FALSE`. The attribute is `TRUE` if the value of *type* is `text` and the value represents category.

3.3 Ruleset of table functions

Each table functions has its own rules. For example the table operation **`pca`** has the following two rules.

1. All values of the input data table must be ordered.
2. All values of the output data table are all ordered.

Table 3 depicts the rulesets of the table functions in Table 3.

3.4 Candidate set of attribute names in options

We define the following rules that can be specified as option values in table functions.

1. for the table function that "all values of the input data table must be ordered" is `FALSE`.

- Arbitrary attribute name of the input table can be specified as the option value of the table function.
- The system can suggest the list of attribute name using the metadata of the input data table.

2. for the table function that "all values of the input data table must be ordered" is `TRUE`.

- If the input data table contains "non-ordered" attribute, the table function can not be evaluated
- The system can suggest to users to use the **`projection`** operation to eliminate all the non-ordered attributes from the input table.

The system estimates the types of intermediate data table using the Table 3.

Table 2: the metadata of the Edgar Anderson's Iris dataset

name	type	is_ordered	is_categorical
Sepal_Length	real	TRUE	FALSE
Sepal_Width	real	TRUE	FALSE
Petal_Length	real	TRUE	FALSE
Petal_Width	real	TRUE	FALSE
Species	text	FALSE	TRUE

Table 3: the ruleset of the table functions. *1: if all values of the input data tab

function name	All values of the input data table must be ordered	All values of the output data table are all ordered
pca	TRUE	TRUE
selection	FALSE	FALSE[*1]
projection	FALSE	FALSE[*1]
frequency	FALSE	FALSE[*1]
cross_table	FALSE	FALSE[*1]
head	FALSE	
plot2d	FALSE	
plot3d	FALSE	
histogram	FALSE	
histogram2d	FALSE	
cluster	FALSE	
GMM_classification	TRUE	
plot_ctree	FALSE	

Table 4: The metadata of the patient data table.

name	type	is_ordered	comment
id_patient	*integer*	*FALSE*	*Unique patient ID*
user_id	*text*	*FALSE*	*Reg. no*
first_name	*text*	*FALSE*	*Patient First Name*
middle_name	*text*	*FALSE*	*Patient Middle Name*
last_name	*text*	*FALSE*	*Patient Last Name*
address	*text*	*FALSE*	*Patient Address*
email	*text*	*FALSE*	*Patient email (in any)*
mobile_no	*text*	*FALSE*	*Contact Number*
password	*text*	*FALSE*	*Password*
sex	*text*	*FALSE*	*Patient Sex, enum('Male','Female')*
height	*text*	*FALSE*	*Height when registered*
weight	*text*	*FALSE*	*Weight when registered*
religion	*text*	*FALSE*	*Patient Religion*
birth_date	*date*	*TRUE*	*Date of Birth*
birth_place	*text*	*FALSE*	*Place of Birth*
reg_date	*datetime*	*TRUE*	*Reg. Date*
l_id	*integer*	*FALSE*	*Site ID*
last_login	*datetime*	*TRUE*	*Last login date time*
is_active	*boolean*	*FALSE*	*Active or inactive*
blood_group	*text*	*FALSE*	*Blood Group*
reg_issuer	*text*	*FALSE*	*Operator who Registered*
age	*integer*	*TRUE*	*Patient Age*

Table 5: The metadata of the prescription data table.

name	type	is_ordered	comment
prescription_id	*integer*	*FALSE*	*Unique Checkup Id*
patient_checkup_id	*integer*	*FALSE*	*Checkup Date*
prescription_body	*text*	*FALSE*	*Blood Sugar*
doctor_id	*integer*	*FALSE*	*PBS/ FBS*
prescription_date	*datetime*	*TRUE*	*Blood Hemoglobin*
symptoms	*text*	*FALSE*	*Blood Pressure Systolic*

4. EVALUATION

We are developing a hospital database system. It contains patient nformation. The information is one data tables. The metadata of the patient data table is defined as shown in Table 4 and Table 5.

5. CONCLUSION

In this paper, we present a data explorer system. In the system, data flows from a source data to data analysis and visualization results are the form of chains of functions for data table. Each function can be implemented easily using R system because R system already has many packages for data analysis and visualization. We already collected patient information in the hospital database system. Statistical analysis of the hospital database is future work.

Acknowledgment

This work was partially executed under the consignment agreement with NEDO.

References

[1] Becker, R. A., Chambers, J. M. and Wilks, A. R., "The New S Language. Wadsworth & Brooks/Cole," 1988.
[2] http://www.r-project.org/index.html
[3] Ward, J. H. Jr. "Hierarchical Grouping to Optimize an Objective Function," Journal of the American Statistical Association, 58, pp. 236-244, 1963.

Trends in The Study of Cloud Computing: Observations and Research Gaps

Hasan Nuseibeh
Information Systems Decision Sciences Department
University of South Florida
4202 E. Fowler Ave., CIS 2082, Tampa, FL 33620, USA
hnuseibe@coba.usf.edu

Dr. Khalid Alhayyan
Department of Computer and Information Programs
Institute of Public Administration
P.O. Box 205, Riyadh 11141, Saudi Arabia
alhayyan@ipa.edu.sa

ABSTRACT

In spite of its potential impact on current business world, cloud computing technology still offers fertile and untapped research opportunities. We conduct a systematic literature reviews for the purpose of identifying research gaps in cloud computing literature. It included 188 referred journal and conference articles. Each article was studied carefully to understand its general theme and then extract a pattern to which the article can be classified. Our review efforts led to the identification of four cloud computing general areas: (1) benefits and risks, (2) adoption, (3) outcomes, and (4) its current state from technological and research perspectives. The study is concluded by introducing a number of research questions that need to be empirically and theoretically investigated. This review provides a reference source and classification for IS researchers interested in cloud computing, and identifies research gaps in the literature.

Keywords: cloud computing, systematic literature review, themes, SAAS, IAAS, PAAS.

1. INTRODUCTION AND ANALYSIS METHOD

Armbrust et al. (2009), define cloud computing as the applications delivered as services over the Internet and the hardware and systems software in the datacenters that provide those services. It is motivated by the construction of large scale datacenters, new technology trends such as scalability and portability, new business models, and new application opportunities such as mobile interactive applications. While information systems research on cloud computing appears to be an emerging area, cloud computing, in practice, has attracted good deal of providers who look for more business benefits and users who seek services that are offered in low cost. However, these stakeholders are still concerned about how reliable these services are with respect to whether to adopt it or not, its benefits/risks, and its outcomes. For the purpose of identifying research gaps in the cloud computing literature, a systematic literature reviews was conducted based on a structured search process. The key word "cloud computing" was used and the search was limited to ABI/INFORM database and Google scholar. These articles were used to draw a pattern and understand the current research areas in cloud computing to identify non-exploited gaps in research. Next, the results, derived from the literature, are discussed leading to number of research questions. To identify its general theme, each article was investigated carefully. Our review efforts led to the identification of four cloud computing general areas: (1) benefits and risks, (2) adoption, (3) outcomes, and (4) its current state from technological and research perspectives, see Table 1.

2. BENEFITS AND RISKS OF CLOUD COMPUTING

2.1 Studies on general benefits and risks

Three studies analyzed the benefits and risks of cloud computing. Hosseini et al. (2010), in an empirical study, studied the benefits and risks while migrating an IT system to the cloud. Blumehnthal (2011) and Aljabre (2012) discussed risks and benefits from their own viewpoints. Table 2 depicts a list the benefits and risks discussed in these studies.

According to Hosseini et al. (2010), cost savings, one of the most perceived benefits of cloud computing, can be realized by migrating a traditional system to the cloud. They empirically investigated the potential benefits and risks associated with the migration of an IT system in the oil and gas industry from an in-house data center to Amazon EC2 from a broad variety of stakeholder perspectives. They studied a single firm where interviews and documents were utilized to calculate the costs and then compare them to their counterparts in amazon EC2 cloud. Their findings indicated that migrating to the cloud introduces significant savings to the company, especially in those costs related to the support and maintenance.

Moreover, Aljabre (2012) found that the cloud computing can also help overcome high infrastructure costs as well as software costs. This finding can open a venue for new startups overcome the high startup cost entrance barriers. Other benefits may include the ability to use the online web services rather than having to develop the same software components internally. The study, also, noted that cloud computing can help facilitate online collaborations for teams that are geographically separated. Other benefits, indicated by Hosseini et al. (2010), referred to the important role that stakeholders of an organization may play through sharing opinions about existing products/services or even suggesting new ones, which lead to improve their satisfaction. Cost effectiveness, scalability, and opportunity for employees to increase their skills are also examples of other benefits. On the other hand, there are several risks associated with cloud computing. Blumehnthal (2011) suggested that risks and benefits of adopting cloud computing need to be studied for each industry independently as they may differ from one to another. Blumehnthal, also, warned from jumping into the cloud without considering many of the security threats of the technology. Security risks may be associated with each level of the cloud source chain starting from a cloud end user, the organization, and the cloud provider. Other risks may be related to services availability, reliability, policy and regulations. For small businesses, Aljabre (2012) suggests that the benefits of cloud computing exceed their risks. This is due to the fact of improving the added value of the small businesses as well as the cost cuts related to the infrastructures and the costs of operations personnel.

Cloud computing research area	Studies
Benefits and risks	Hosseini et al. (2010), Blumehnthal (2011), Aljabre (2012), Morar et al. (2011), Russell et al. (2010), Wang (2010), Katzan (2010), Rose (2011), Bisong and Rahman (2011), Durowoju et al. (2011), Marston et al. (2011), Berman et al. (2012).
Adoption	Heinle and Strebel (2010), Low et al. (2011), Yang and Hsu (2011), Barnes (2010), Truong and Dustdar (2010), Klems et al. (2009), Vaezi (2012) .
Outcomes	Etro (2011), Truong (2010), Sharif (2011), Bajenaru (2010), Shen (2011), Han (2011).
Current state	Marston et al. (2011), Zhang et al. (2011), Hosseini et al. (2010), Wang et al. (2011), Limbasan (2011), Armbrust et al. (2009), Hoberg et al. (2012).

Table 1 –Research Areas

Benefits	Risks	Studies
Cost savings	Security threats	Hosseini et al. (2010) Aljabre (2012) Blumehnthal (2011)
Opportunity to concentrate on core competencies	Availability	
Elasticity of service	Reliability of service	
Facilitate online collaboration	Regulations	
Modules reusability	Privacy concerns	
	Lack of standards	

Table 2- General Benefits and Risks of Cloud Computing

2.2 Studies on specific risks or benefits

Several studies went into studying one specific benefit or risk of cloud computing. For instance, Morar et al. (2011), in an empirical study, explored the increased efficiency. Two other empirical studies investigated the potential risks of using cloud computing technologies in an organization such as the risks on service availability by Russell et al. (2010), and the risks on privacy by Wang (2010). Durowoju et al. (2011) studied the effect of security and scalability on cloud business processes. Table 3 summarizes some details about these studies. The efficiency, offered by Morar et al. (2011) as a benefit, emerges from the capability of employing virtually unlimited resources depending on the processing power or storage needs. They demonstrated how workflows and cloud resources can be used to achieve speedup for an application without the need of spending large amounts of money on computational resources. A case study was implemented using a workflow for an E-bay data retrieval application. A simulation was then run using a system that demonstrated how a better speedup can be achieved by paralyzing certain sections of the application just by a workflow with a parallel section and without need for high parallel programming skills. They found that their system using cloud parallelism improved scalability and achieved high speedups that were significantly better than not using the system. Russell et al. (2010) evaluated the effects of fluctuations in cloud service availability on the successfulness of decision outcomes in a Decision Support System (DSS) context. For the purpose of their study, researchers used a simulated decision making scenario of a trading stock chosen from S&P500. They used probabilistic model to model resource availability and then evaluated the effect of interruption of service on the outcome of the DSS. The study concluded that availability context information can impact the efficacy of cloud-based DSS. Additionally, there is a probabilistic relationship between decisions related computing resource availability and correct decision outcomes.

Based on the queuing theory, the second stage looked at why scalability is an important consideration in selecting cloud partners and how it can be evaluated. The study found that a cloud service can only prove beneficial to supply partners under a highly secured and highly scalable computing.

Katzan (2010) advices that privacy should be evaluated and understood before adopting cloud computing, and notes that privacy is more complicated in a cloud context in terms of laws, policies, and consequences. On the other hand, Rose (2011) warned from the risk caused by the tragedy of the commons. That is, organizations sharing a cloud would share the fate with other organizations in the same cloud. So that, if the data or the cloud service of an organization gets attacked, crashes, or consumes higher than expected resources, this would affect the performance of the whole cloud, and may compromise the availability of the cloud for all organizations sharing it

Bisong and Rahman (2011) and Marston et al. (2011) discussed security in cloud computing and suggests steps that an enterprise can take to reduce security risks and protect their resources. Authors recommended that organizations should carefully verify and understand issues related to cloud security, analyze them, and plan for ways to resolve them before implementing cloud computing. Finally Berman et al (2012) surveyed 572 business and technology executives across the globe. The results indicated that although cloud computing was recognized as an important technology, its full potential was not yet exploited. The research identified three categories of "business archetypes", which explains the use extent of cloud computing in organizations. These archetypes are: (1) the optimizers that used cloud to improve efficiency of their business, (2) the innovators that created new cloud based revenue streams within their ecosystem, and (3) the disruptors that created totally different value propositions.

3. ADOPTION OF CLOUD COMPUTING

The second general area of research is the adoption of cloud computing. Four empirical studies identify the organizational determinants of the cloud computing adoption. Low et al. (2011) studied factors that affect the adoption in high-tech industry. Heinle and Strebel (2010) studied the determinants of the adoption of infrastructure as a service (IaaS) in organizations. On the other hand, Yang and Hsu (2011) suggested using a different approach (organization lese) for studying the adoption of cloud computing at an industry level. Vaezi (2012) used the grounded theory approach and collected secondary data sources (e.g. interviews and case studies) to build a general framework that would help better understand cloud computing from different perspectives. Different papers used different theoretical models and different theories to understand the adoption decision. For instance, Heinle and Strebel (2010) developed a theoretical model of IaaS acceptance which focused on drivers and barriers for adopting IaaS.

Study	Benefit/Risk	Context	Main Findings
Morar et al. (2011)	Efficiency	Workflows	Using cloud parallelism improved scalability and achieved higher speed
Russell et al. (2010)	Service availability	DSS	Even minor availability fluctuations caused serious changes in results of DSS
Wang (2010)	Privacy	Cloud Databases	Developed two privacy models for cloud DBs.
Durowoju et al. (2011)	Security/Scalability	Cloud enabled Business Functions	Guidelines to evaluate security and scalability
Berman et al (2012)	Innovation	Processes and Business model	Guidelines to help drive business innovation.

Table 3 – Studies on Specific Risks or Benefits of Cloud Computing

The model was tested using expert's interviews and found that some of the most important drivers are the existence of innovation champions in organizations, and the existence of positive IaaS provider's characteristics such as: relative and absolute size and positive reputation. These factors were found to positively affect IaaS adoption propensity. They also found that some of the most important barriers are the lack of understanding of IaaS and difficulty in cost-benefit evaluation of current IaaS offerings. Low et al. (2011) used Technology-Organization-Environment (TOE) to develop a theoretical model that investigated the factors that hinder firms in the sector of the high-tech industry from adopting the cloud computing. A questionnaire-based survey was used to collect data from 111 firms in Taiwan. Relevant hypotheses were derived and tested. It was found that relative advantage, top management support, firm size, competitive pressure, and trading partner pressure characteristics had a significant effect on the adoption of cloud computing. On the other hand, Yang and Hsu (2011) used a different approach for studying the adoption at the industry level, namely through the lens of "organizing vision", therefore recognizing the role of the industry as a whole on single organizations. They presented a secondary analysis on the institutional processes of forming the cloud computing industry in Taiwan. The authors note that an organization should not be studied individually and that each individual organization belongs to the complex community of organizations in the dialogue process of technology development. The study found that when considering adoption decision, many considerations do not come from within the organization; rather, they are embedded in a larger community network, connecting mainly with internal cycles of interpretation to those at the institutional level.

To help with the adoption decision, a study by Klems et al. (2009) proposed a basic valuation step-by-step guiding framework to estimate the value of cloud computing and compare it to conventional in-house IT infrastructure. Finally, Vaezi (2012) utilized interviews, case studies and published journal articles to analyze the landscape of adopting cloud computing from different perspectives using grounded theory approach. He found different categories of adoption related concepts in the literature. Those categories were: causal conditions, phenomenon (cloud computing), contextual conditions, intervening factors, action/reaction strategies, and consequences of the phenomenon. A theoretical model was built on those categories, and it depicted factors that intervene with adoption, in addition to strategies for successful adoption. Table 4 summarizes the articles reviewed on the area of adoption of cloud computing. In addition to the above studies, two conceptual studies discussed the adoption in particular contexts, suggesting some enablers and barriers of cloud computing. For instance, Barnes (2010) discussed migrating records and Records and Information Management (RIM) to cloud computing, introducing cloud computing to RIM community. Barnes offered some advices on choosing vendor, and noted that cost, security, performance availability, business viability, and legal compliance issues should be evaluated. On the other hand, Truong and Dustdar (2010) studied adoption of cloud computing for small CSE research groups. They have identified several issues that prevent a wide adoption of cloud computing by small CSE research groups such as the non-existence of cost estimation tools, and complexity of using IaaS for researchers. They also identified some benefits such as cost savings, improvement of data sharing, and researches outcomes.

4. OUTCOMES OF CLOUD COMPUTING

The area of cloud computing outcomes is the area that studies the impacts of cloud computing on industry, organizations, and businesses. Most of the investigated studies expressed an optimism vision of the cloud computing on users. These visions were based on personal views but not on empirical observations. At a macroeconomic level, Etro (2011) used a macroeconomic simulation model to study the impact of cloud computing on the European economy in the next few years. Etro found that diffusion of cloud computing can provide a positive annual growth rate, and can help create new jobs every year through the development of new Small and Medium Enterprises (SMEs). There would also be savings in public sector. On the other hand, Truong (2010) developed a research model of cloud computing on an organizational level from a managerial perspective that focused on small businesses. Truong discussed how to use cloud computing to enhance competitive advantage for small businesses, and used the resource-based view of the firm to suggest customizable cloud computing offerings and inter-connectivity. That is, public cloud computing may offer an opportunity to better interconnect and collaborate with partners and customers. Also, the alignment in the strategic use of cloud computing resources within the company and between partners can help organizations achieve a competitive by affecting the innovation and collaboration at the organization. This relation is moderated by Security, intellectual property, and reliability of cloud services. According to the authors this would lead to a rare and un-substitutable competitive advantage.

On a business sector level Sharif (2011) suggested that the promise of cloud computing is not a hype. It can actually revolutionize businesses if it is used and adopted properly, and can create whole new business sectors and industries similar to the Internet revolution by allowing an exponential growth of businesses almost instantly which is facilitated by the scalability of cloud computing and by the flexibility. This can occur by allowing organizations to select software components, hardware, and services based on their requirements. Bajenaru (2010) notes that cloud computing can have an important role in narrowing what he calls the "digital divide" between large enterprises and SMEs.

Study	Theories used	Method	Enablers	Barriers
Heinle and Strebel (2010)	Agency, DOI, IT governance theories	Experts interview	• **Innovation champions** • **Cost transparency** • **Provider characteristics**	• **Unclear definition** • **Difficult cost-benefit evaluation** • **Unknown organizational impact** • **Difficulty in assessing provider risk** • **Service availability risks** • **Lack of standards** • **Legal risks** • **Security** • **Lack of monitoring tools**
Low et al. (2011)	Technology-Organization-Environment Framework	Questionnaire-based survey	• **Relative advantage** • Compatibility • **Top management support** • **Firm size** • Technology readiness • **Competitive pressure** • **Trading partner pressure**	• Complexity
Yang and Hsu (2011)	Organization Vision	Secondary analysis	• **Community discourse, structure, and commerce.** • IS practitioner subculture. • Adoption of core technology. Adoption and diffusion.	
Vaezi (2012)	Developed own model	Grounded Theory	• **Infrastructural Expenses** • **Unpredictable demand** • **Fluctuating demand** • **Ubiquitous demand**	• **Security/Privacy** • **Service Availability** • **Pricing Models** • **Legal Considerations**

Table 4: Empirical Studies on Determinants for Adoption of Cloud Computing.
*note: bold font refer to variables that were found to be significant

With the emergence of cloud computing, SaaS (Software as a Service) SMEs are able to use large-scale systems such as Enterprise Resource Planning (ERP) or Customer Relationship Management (CRM) systems, which are too expensive and are exclusively used by large enterprises. Shen (2011) argues that cloud computing can transform Business intelligence (BI) applications to a self-service process, and can improve BI in the areas of information agility, data accessibility, process transformation, cost reduction, scalability, efficiency and performance. This can also help enterprises concentrate on their core competencies. Han (2011) presented his experience in migrating an existing library system to the cloud. The author noted that using cloud computing brought significant cost savings that reached up to 90% as well as to flexibility to the system. The author also believed that the system's availability and security, in general, were better than the system running in-house. Table 5 summarizes the articles on the area of outcomes of cloud computing.

5. STUDIES ON CURRENT STATE OF CLOUD COMPUTING RESEARCH

Many recent studies still present the basic concepts of cloud computing and attempt to identify the current state and possible research areas in cloud computing (Marston et al. 2011, Zhang et al. 2011, Hosseini et al. 2010, Wang et al. 2011). Research agendas suggested in these studies are summarized in Table 6. Marston et al. (2011) introduced cloud computing and studied its strengths, weaknesses, opportunities, and threats. They offered recommendations for business professionals on which applications (e.g. CRMs at salesforce.com) to move to the cloud and which kind of organizations should adopt cloud computing. However it may be early for legacy systems or internally developed applications to be migrated to the cloud. They also suggest that SMEs can benefit from migrating to the cloud more than large organizations due to the cost-benefits. This is due to the fact that larger organizations may already have cost efficiency in their ICT systems, however they may benefit from virtualization technologies. The authors highlighted some areas of research such as economic benefits, strategy research such as impact of cloud computing on corporate culture, information systems policy, technology adoption and implementation research, and government policy/regulation research. Zhang et al. (2011) surveyed the state-of-the-art of cloud computing. They covered the cloud essential concepts and architectural designs. They also presented a survey of commercial cloud products available, technologies, and some computer science research directions. Other research areas were discussed by Hosseini et al. (2010) as well. They noted that there are many dimensions that need further investigations in the context of cloud computing such as organizational changes (the new role of IT department, the political power change, and the economic and organizational implication of cloud). Additionally, security, legal, and privacy issues, related to the cloud computing, raise the need for more research investigation. Wang et al. (2011) presented a brief summary on the analysis of current gaps and new trends in cloud computing research. They suggest that the cloud computing is one of the most important technological shifts within last decade, and as technology the growth rate is increasing rapidly, it poses huge challenges for companies to stay up-to-date with current state of technology trends. The study categorizes research in cloud computing into technical and organizational research. The authors argues that there are several research issues like socio-technical impact of cloud computing and reliability that has not been addressed much in the literature. Also, there has not been enough attention in research on exploring the managerial processes of cloud computing development. They also call for studying the value of adopting cloud computing services in contrast to using traditional model. They also call for studying the impact of this transformation on productivity and on the organization level as a whole.

Study	Level/Context	Outcomes/Impact
Etro (2011)	Macroeconomic	• Positive annual growth rate, • Help create new jobs every year through the development of new SMEs. • There would also be savings in public sector.
Truong (2010)	Organization	• Offers a prescription for getting an un-substitutable competitive advantage
Sharif (2011)	Business Sector	• Revolutionize businesses • Create whole new business sectors and industries similar to the Internet revolution
Bajenaru (2010)	Business Sector	• Cloud computing can narrow the "digital divide" between large organizations and SMEs
Shen (2011)	BI Applications	• Transform (BI) apps to a self-service process • Improve BI in the areas of information agility, data accessibility, process transformation, cost reduction, scalability, efficiency and performance.
Han (2011)	Library System	• Cost savings up to 90% • More flexibility • Better availability and Security

Table 5: Outcomes/Impact of Cloud Computing Studies.

Although no studies were found that fully applies a design science method (Hevner et al., 2004) to study the cloud, Limbasan (2011) created a CRM prototype. They used several approaches of e-marketing and SaaS features and architectures to create a model for a CRM solution using SaaS Level 2 architecture and distributed database. They developed a modular solution for solving CRM and e-marketing targets in real estate companies. Finally Hoberg et al. (2012) reviewed the literature in cloud computing from a business perspective. They identified four dimensions of research cloud computing: characteristics, adoption determinants, governance mechanisms, and business impact. It was found that although there has been a shift from the technical research dimension of cloud computing that was the main focus of research, there is still not enough empirical research from a business perspective.

6. CONCLUSION AND IDENTIFIED GAPS

The review conducted in this paper shows that a significant part of the research in cloud computing is related to the studies discussing the risks and benefits of cloud computing. Examples of identified risks were: service availability, privacy, security threats, service reliability, lack of regulations, and lack of standards. On the other hand, cost savings, scalability, focus on core competencies, elasticity of service, facilitation of online collaboration, and reusability were identified examples of the research efforts need to be theoretically and empirically supported with statistical evidences for opening new venues for researchers and practitioners. The second area of research is related to the adoption of cloud computing at the organizational level. Our review indicated that no studies were found that deal with adoption at different levels such as individual or industrial. This can be considered a research gap since cloud computing may also impact individuals as well. For instance, SaaS service is widely used as office suits and file storage. What is the extent to which this transformation will change the individuals' activities? Additionally, the factors (or constructs), which may cause successful adoption of cloud computing, are still vague. Moreover, what would be the reasons for failed adoption of the cloud? The outcomes of implementing the cloud computing are another research area identified in this paper. While introduced many optimistic outcomes, existing studies in this arena are still considered personal views that lack empirical observations based on theoretical models. This would bring an opportunity to investigate the possible impacts on the organization adopting the cloud, on the workforce, and on the level of expertise in that organization. Last, several design-science research opportunities exist for possible investigations. Of course, interesting research problems are those that are derived from practical experiences. While there are many, the obstacle of migrating a legacy system to the cloud can be mitigated if a trusted model exists to guide the process of migrating legacy software into a SaaS model, which may be a problem that organizations may face eventually if SaaS becomes the main platform trend. To conclude, our review study on cloud computing identified a number of research gaps for future research studies. We introduce a number of research questions that need to be empirically and theoretically investigated.

- What factors contribute to the successful adoption of cloud computing in an organization?
- What factors contribute to the adoption of cloud computing services at a personal level?
- What are the effects (outcomes) of adopting cloud computing in organizations, how does it change the organization, and how is that perceived?
- How can an organization build a cloud strategy to achieve a competitive advantage over competitors?
- How can an organization choose a cloud provider or cloud offerings? Which services to migrate to cloud computing? (Model building from design science).

7. REFERENCES

[1] Abdulaziz Aljabre. (2012). **Cloud Computing for Increased Business Value**. International Journal of Business and Social Science, 3(1) Retrieved February 1, 2012, from ABI/INFORM Global. (Document ID: 2550052461).

[2] Alexandru, B. (2010). **Software as a Service and Cloud Computing, a solution for small and medium-sized companies.** Bulletin of the Trasilvania University of BRsov, 3(52).

[3] Amir M Sharif. (2010). **It's written in the cloud: the hype and promise of cloud computing.** Journal of Enterprise Information Management, 23(2), 131-134.

[4] Armbrust, M., A. Fox , R. Griffith, A. Joseph , R. Katz ,A. Konwinski, G. Lee, D. Patterson, A. Rabkin, I. Stoica, M. Zaharia (1977). **Above the Clouds: A Berkeley View of Cloud Computing,** Technical Report No. UCB/EECS-2009-28.

[5] Barnes, F. R. (2010). **Putting a lock on Cloud-Based** Information. Information Management Journal, 44(4), 26-30. ARMA International.

[6] Berman, S. J., Kesterson-Townes, L., Marshall, A., & Srivathsa, R. (2012). **How cloud computing enables process and business model innovation.** Strategy & Leadership, 40(4), 27-35 Chicago.

[7] Blumenthal, M.. (2011). **Is Security Lost in the Clouds?** Communications and Strategies,(81), 69-86.

Study	Research Gaps
Marston et al. (2011)	• Economic benefits of cloud computing • Impact of cloud computing on corporate culture • Information systems policy • Technology adoption and implementation research • Government policy/regulation research.
Hosseini et al. (2010)	• Organizational changes caused by the migrating to the cloud • Political changes in power • Economic and organizational implication of cloud • Security, legal and privacy issues that cloud computing raises
Wang et al. (2011)	• Socio-technical impact of cloud computing • Reliability of cloud computing. • Exploring the managerial processes of cloud computing • Value of adopting cloud computing services in contrast to using traditional model • Impact of adoption on productivity and on the organization as a whole.
Hoberg et al. (2012)	• Customer-perspective of cloud computing • Empirically studying Factors driving or inhibiting the adoption of cloud services • Business impact • Research on structures, processes and employee qualification to govern cloud services from a customer's perspective

Table 6: Areas of Research suggested by studies

[8] Chinyao Low, Yahsueh Chen, Mingchang Wu, (2011), **Understanding the determinants of cloud computing adoption**, Industrial Management and Data Systems, Vol. 111 Iss: 7, pp.1006 – 1023.

[9] Durowoju, O., Chan, H., and Wang, X.. (2011). **The impact of security and scalability of cloud service on supply chain performance.** Journal of Electronic Commerce Research, 12(4), 243-256. Retrieved February 1, 2012, from ABI/INFORM Global.

[10] Dwivedi, Y. K., and Mustafee, N. (2010). **It's unwritten in the Cloud: the technology enablers for realizing the promise of Cloud Computing.** Journal of Enterprise Information Management, 23(6), 673-679.

[11] Etro, F. (2011). **The Economics of Cloud Computing.** Computing, 7(6), 1-12.

[12] G Shen (2010). **Cloud Computing—The Catalyst for Self-Service BI-Cloud,** Information Management New York:Sep 1, 2011. Vol 21, Iss 5 pg20.

[13] Han, Y.. (2010). **On the Clouds: A New Way of Computing.** Information Technology and Libraries, 29(2),87-92.

[14] Heinle, C., and Strebel, J. (2010). **IaaS Adoption Determinants in Enterprises.** (R. Altmann J Rana O F Buyya, Ed.) Computing, 6296 LNCS, 93-104. Springer.

[15] Hevner, A.R., S.T. March, J Park, and S. Ram (2004), **Design science in information systems research**. MIS Quarterly, 28, 75-105.

[16] Katzan, H.. (2010). **On The Privacy Of Cloud Computing**. International Journal of Management and Information Systems, 14(2), 1-12.

[17] Khajeh-hosseini, A., and Greenwood, D. (2010). **Cloud Migration : A Case Study of Migrating an Enterprise IT System**. Information Systems Journal, abs/1002.3, 450–457.

[18] Khajeh-Hosseini, A., Sommerville, I., and Sriram, I. (2010). **Research Challenges for Enterprise Cloud Computing.** Information Security, Retrieved from http://arxiv.org/abs/1001.3257.

[19] Klems, M., Nimis, J., and Tai, S. (2009). **Do Clouds Compute? A Framework for Estimating the Value of Cloud Computing.** (C. Weinhardt, S. Luckner, and J. Stößer, Eds.) Computing, 22, 1-13.

[20] Limbasan, A., and Rusu, L.. (2011). **Implementing SaaS Solution for CRM.** Informatica Economica, 15(2), 175-183. Retrieved February 9, 2012, from ABI/INFORM Global.

[21] Marston, S., Li, Z., Bandyopadhyay, S., Zhang, J., and Ghalsasi, A. (2011). **Cloud computing — The business perspective.** Decision Support Systems, 51(1), 176-189. Elsevier B.V.

[22] Mei, L., Chan, W. K., and Tse, T. H. (2008). **A Tale of Clouds: Paradigm Comparisons and Some Thoughts on Research Issues.** 2008 IEEE AsiaPacific Services Computing Conference, 0(i), 464-469. IEEE.

[23] Morar, G., Muntean, C., and Silaghi, G.. (2011). **Implementing and Running a Workflow Application on Cloud Resources.** Informatica Economica, 15(3), 15-27. Retrieved February 1, 2012, from ABI/INFORM Global.

[24] Mustafee, N. (2010). **Exploiting grid computing, desktop grids and cloud computing for e-science: Future directions.** Transforming Government People Process and Policy, 4(4), 288-298. Emerald Group Publishing Limited.

[25] Patrick Hoberg, Jan Wollersheim, and Helmut Krcmar, **The Business Perspective on Cloud Computing - A Literature Review of Research on Cloud Computing** (July 29, 2012). AMCIS 2012 Proceedings. Paper 5.

[26] Rahman, M. and Bisong, A., Syed. (2011). **An Overview of the Security Concerns in Enterprise Cloud Computing.** Network Security, 3(1), 30-46.

[27] Reza Vaezi, **Cloud Computing: A Qualitative Study and Conceptual Model,** (July 29, 2012). AMCIS 2012 Proceedings.Paper 3.

[28] Rose, C.. (2011). **A Break In The Cloud? The Reality Of Cloud Computing.** International Journal of Management and Information Systems, 15(4), 59-63.

[29] Russell, S., Yoon, V., and Forgionne, G.. (2010). **Cloud-based decision support systems and availability context: the probability of successful decision outcomes.** Information Systems and eBusiness Management, 8(3), 189-205.

[30] Truong, D. (2010). **How Cloud Computing Enhances Competitive Advantages: A Research Model for Small Businesses.** The Business Review, Cambridge, 15(1), 59-65.

[31] Truong, H., and Dustdar, S. (2011). **Cloud computing for small research groups in computational science and engineering: current status and outlook.** Computing, 91(1), 75-91. doi:10.1007/s00607-010-0120-1.

[32] Vaezi, R. (2012). **Cloud Computing: A qualitative study and conceptual model,** AMCIS2012 Proceedings, Paper 3.

[33] Vouk, M. A. (2008). **Cloud computing — Issues, research and implementations.** ITI 2008 30th International Conference on Information Technology Interfaces, 16(4), 31-40. IEEE.

[34] Wang, H.. (2010). **Privacy-Preserving Data Sharing in Cloud Computing.** Journal of Computer Science and Technology, 25(3), 401-414.

[35] Wang, W., Rashid, A., and Chuang, H.. (2011). TOWARD **The Trend Of Cloud Computing**. Journal of Electronic Commerce Research, 12(4), 238-242. Retrieved February 14, 2012, from ABI/INFORM Global. [36] Yang, S., and Hsu, C (2011). **The Organizing Vision For Cloud Computing In Taiwan**. Journal of Electronic Commerce Research, 12(4), 257-271. Retrieved February 1, 2012, from ABI/INFORM Global. (Document ID: 2546687231).

[37] Zhang, Q., Cheng, L., and Boutaba, R. (2010). **Cloud computing: state-of-the-art and research challenges.** Journal of Internet Services and Applications, 1(1), 7-18. Springer London.

Dynamic Fair Division of Duties for Sensor Management

Mark Rahmes
Rick Pemble
George Lemieux
Kevin Fox

Harris Corporation,
Government Communications Systems Division
Melbourne, Florida 32904

ABSTRACT

Our goal is to inspire a method for analysts to dynamically allocate sensor resources. In this paper we discuss fair division for optimal resource allocation and management. Agent's demand for limited resources as a function of time must be dynamic and fair. The context of fair means that first available request for an asset is not envied as long as it is not yet allocated or tasked in order to prevent cycling of the system. This solution may also save money by offering a Pareto efficient repeatable process for division of duties. We combine operations research methods and remote sensing for decision making with several possible actions, state of the world, and a mixed probability metric. Our tool allows for calculating optimal strategies, provides greater knowledge about the state of the world, and increases the likelihood of a decision maker making the best decision. The motivation for fairness is used to ensure that not all sensor assets are dominated by one agent or player. We use a water fill queue algorithm to include Shapley value marginal contributions for allocation of demands by sensor modality. This is needed in order to not miss any important events occurring around the world.

Keywords: Game theory, Resource Management, Decision Making, Operations Research

1. INTRODUCTION

The Joint Directors of Laboratories (JDL) defined data fusion as a process for associating, correlating, and combining data and information from multiple sources and sensors to assess situation and threats and their significance. Data fusion is important for determining a strategy for handling current and potential future situation awareness and minimization of uncertain information content. Other elements for decision making under uncertainty are resource management and data mining which are also essential [8]. Our contribution in this paper is to combine data fusion with dynamic fair division.

The JDL model serves as a framework for containing functions which a system should provide operational knowledge. Data fusion is an element of a larger information processing cycle (IPC) [16]. Resource management is an important component which must translate the decision maker's information needs to real world actions. The orchestration of sensors and identification of sources to produce relevant input for a fusion process is referred to as resource management. Resources are the technical means employed to gather essential data [8].

We consider an environment where agents arrive with sensor assets requests over time. Our aim is to design irrevocable resource allocation such that more assets can be allocated to an agent, but can never be taken back. For fairness, envy freeness means that agents like their own allocation best and are truthful needs [6]. Our contribution is a unique application applied to multiple agents with sensor tasking requirements with limited resources. Like fusion, the increase in the number of information sources requires some level of automation. We correlate world events to sensor priorities given open unstructured, source data and create a reward matrix and volumes to solve for optimal tasking strategies [10].

Current situational awareness requires efforts to seek to incorporate not only geospatial features and forces structures, but also the human element, especially in urban settings. An attempt to predict the likelihood of reaction to a future event will be based on correct situation analysis. Efforts to combine the information required for these predictions are time consuming and labor intensive. The availability of open source social media information and implementation of artificial intelligence (AI) methodologies makes this problem tractable. Our GlobalSite system can also be used as a method for asset management and to reduce cost of analyses [11].

2. GAME THEORY

Game theory considers the effect of a player's decision on other decision makers. Two or more decision makers choose an action that affects rewards earned by players. In general, competitive game theory is useful for making decisions in cases where the decision makers have differing interests [15].

In many situations, the opponents know the strategy that they are following. We assume that the players know what actions are available. A maximin equilibrium often is the strategy and is called the Nash theory application of zero or constant sum strategy game. We also consider a constant sum game in which for both player's strategies, the two player's reward add up to a constant value. This means, while both players are in conflict, that there is more to gain than simply having one player's reward equaling the other player's loss.

We can find optimal strategies for this two-person zero-sum game [15]. For example, if a reward matrix exists, then the equilibrium point is the one where the reward is the smallest value in its row and the largest number in its column. A pure strategy provides a complete definition of how a player will play a game. A player's strategy set is the set of pure strategies

available to that player. A mixed strategy is an assignment of a probability to each pure strategy. This equilibrium is also known as the Nash Equilibrium. The value of the game is the local minimum in one row and a local maximum in one column [9].

Game theory is divided into two branches, non-cooperative and cooperative [1]. Algorithms for computing Nash equilibrium are well-studied. N-player games are computationally harder than 2-player games, in important ways such as visualization of the solution [7]. We extend the 2D reward matrix to a 3D reward volume. This volume can be solved for Nash Equilibrium along xy, yz, and xz axes. Our solution shows how one would you draw a 3 player payoff matrix and can be used to solve Nash equilibrium in a 3 player game. Figure 1 shows an indexed reward volume for 4 or more players.

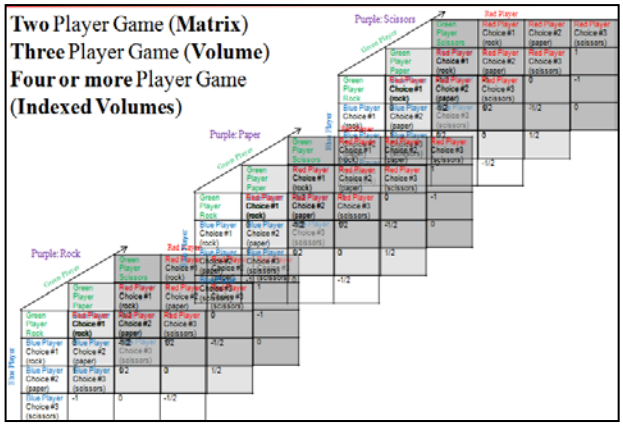


Fig. 1. Example 4D Reward Volumes (Rock, Paper, Scissors)

3. SENSOR PRIORITY COST FUNCTION

In our example, we correlate world events to sensor priorities. The cost function for actions (sensors) for top national problem using the U.S. Unfavorability/Threat Rating from the PEW Research Center is as follows [17]:

- Optical
  - War/Conflict
  - Terrorism
  - Immigration
- Social Media
  - Humanitarian Aid
  - Arab Spring
  - Crime
- LiDAR (Spectral and Geospatial)
  - Drug Trafficking
  - Nuclear, Biological, Chemical (NBC) Warfare [6]
  - Pollution

Our solution concept for *n*-person games involves using multi-dimensional reward volumes. Given an *n*-person game, with a cost function (Nash Equilibrium game value) v, there is a reward vector $\mathbf{r} = (v_1, v_2, \ldots, v_n)$. The reward of the i^{th} player (r_i) is given as a function of:

- $r_i = \max(\text{value}(v_i(P)))$
- $v \in \forall P$, *where* $|P|$ *is the number of players*

Given, v has a cost function, $c{:}v_i(P) = c(P \in i) / \sum c(\forall P \notin i)$.

We map the cost function per player and sensor (optical, social media, and LiDAR sensors) as shown in Table 1. We let the cost function be equal to numerator (country's value for a sensor modality cost) divided by sum of all other country's associated modality costs.

Table 1. Cost Functions

	Optical	**Social Media**	**LiDAR**
Pakistan	Conflict (+1) Terrorism (+1) Immigration (+1)	Crime (+1)	Pollution(+1) Drugs (+1)
Sudan	Civil War (+2)	Humanitarian Aid (+1)	
Palestine	Terrorism (+1) Immigration (+1)	Crime (+1) Humanitarian Aid (+1)	Drugs (+1)
Iran	Conflict (+1)	Arab Spring (+1)	NBC Warfare(+3)

4. SENSOR ASSET MANAGEMENT EXAMPLE

For the example shown in Figure 2, the value for optical is as follows: 3/(2+2+1) = 3/5, given that the values for optical are 3, 2, 2, and 1 for Pakistan, Sudan, Palestine, and Iran respectively. Note that the game value itself accounts for diminished subject player gains (numerator) by competing players gains (denominator).

Technological advances in sensing, computation, storage, and communications will turn the near-ubiquitous mobile phone into a global mobile sensing device. People-centric sensing will help drive this trend by enabling a different way to sense, learn, visualize, and share information about ourselves, friends, communities, the way we live, and the world we live in. It juxtaposes the traditional view of mesh sensor networks with one in which people, carrying mobile devices, enable opportunistic sensing coverage [2].

In our example, there are several resource management stages. These stages include information needs, collection objectives, observables, tasks and plans. The resource management process seeks to decompose information needed to satisfy mission objectives into one or more tasks. The essence of resource management is uncertainty management [8]. Resource allocation problems in which limited resources must be allocated among several activities are often solved by dynamic or linear programming. Operations Research is a branch of mathematics that studies decision making to obtain the best decision. Game theory can help determine the optimal investment strategy [15].

Our solution populates a reward matrix in near real time through powerful game theory analysis. Once data accuracy is proven through sensitivity analysis, the information can either be used as training data or populated into a reward matrix for resource allocation and adversarial planning utilizing game theory concepts such as in a competitive or cooperative game model. Much of the current focus is on human geography and terrain as well as population based sentiment analysis [12].

Figure 2 show populated example values for a four player game given three choices for sensor classes: optical, social media, and LiDAR. We use the Nash equilibrium to solve for the mixed solutions in a repeatable and methodical manner to determine optimal choices. In our example, open source data is used to create a cost function. We use the Shapley value [13] to optimize number of Nash combinations.

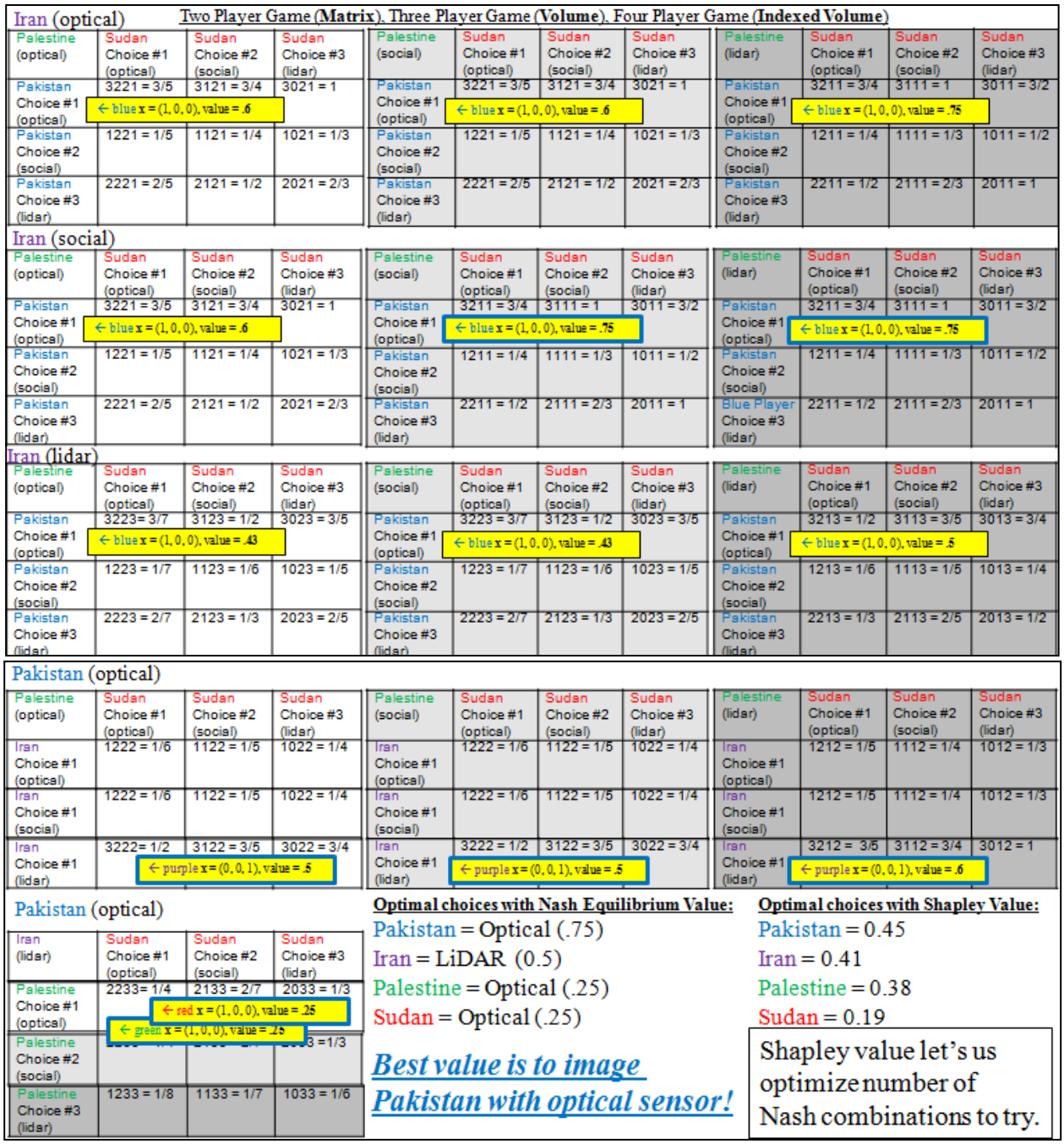


Fig. 2. Example Sensor Priority Strategy Solution

5. DYNAMIC FAIR DIVISION

One issue with our example is modeling asset management with limited resources for multiple sensor modality requirements. One solution is to run the Shapley and Nash algorithms for each successive tasking request. However this alone lacks a correlation to available assets.

We next run a dynamic fair division algorithm to ensure that each request is fair with respect to limited available assets. The motivation for fairness is used to ensure that not all sensor assets are dominated by one agent or player (region of interest). This is needed in order to not miss important events occurring around the world.

Walsh proposed the problem of fair cake cutting where agents arrive, take a piece of cake, and immediately depart. The cake cutting setting deals with the allocation of a single, heterogeneous divisible resource; our setting deals with multiple, heterogeneous divisible resources. This permits exploration of the concept of fair division when players arrive and depart during the process of dividing a resource. It can be used to model situations when there is a need to divide resources asynchronously [14]. The indivisible quality of this method that we are concerned with is time of asset use.

We have chosen to model the solution based on fair division rather than dynamic queuing where an agent requirements arrive and departs with a solution allocating one sensor per agent in succession [3]. Queuing is an option and is part of the system. However we choose to look at resource management using fair division since it has additional benefits of computational intelligence.

Similar to Kash et al. [6], we denote the number of agents with sensor requirements as N = {1,…, n}, and the amount resources agent i requires as R_i. Our example is different in that we consider some sensors as unlimited while others are limited. The demand D_{ir} is the fraction of resource r required by agent i. However in our example, the value for social media may be considered unlimited, so we always denote social media as having N resources available. Additionally we compute the utility function, with a Shapley value, of an agent as the fraction of its dominant resource that it can actually use.

Ever since, content provided by ordinary people, so-called "citizen journalists" or individuals with particular agendas that is posted or shared on Social Networks such as Twitter, YouTube, Facebook, MySpace or Flickr, to name but a few, has increasingly made it into the channels and services of traditional information providers such as news organizations. New and affordable publishing and distribution tools for ordinary citizens such as Social Networks, blogs, or services have made this possible. Social Networks have more and more become an integral part of the communication mix for all kinds of aims, for example (political) campaigning, and awareness-raising [4].

A trivial solution is simply to allocate resources based on a first come – first served basis and allocate 1/n shares to each agent. A dynamic allocation mechanism is dynamic envy free (DEF) if at any step an agent i envies an agent j only if j arrived before i did and j has not been allocated any resources since i arrived [6].

Before a sensor modality is tasked, we allow the agent to be able to give the asset back if envied by another agent with a higher requirement, determined by the Shapley marginal contributions shown in Fig 3. Instead of simply allocating equal shares to all players, we recognize that certain regions of interest (agents, players) demand more assets at a given time due to real world crisis situations. Therefore we propose using the Shapley value as the percentage of resources to be allocated to agents. In our example the optical and LiDAR assets are limited while the social media sensors are considered unlimited. However, the use of the right sensor at the right time has a higher value. Our solution considers the use of some sensor use may be better than none. It depends on the situation.

Blue, Red, Green, Purple (Cooperative)

Order	Marginal Contributions	
optical	3/5, 1/3, 1/3, 1/7	$\Phi_1(v) = 0.45$
social	1/4, 1/4, 2/3, 1/4	$\Phi_2(v) = 0.19$
lidar	1/2 0, 1/5, 1	$\Phi_3(v) = 0.38$
optical, social	4/9, 3/10, 4/9, 2/11	
optical, lidar	5/9, 1/6, 3/11, 4/10	
social, lidar	3/8, 1/10, 3/8, 4/7	$\Phi_4(v) = 0.41$
optical, social, lidar	6/13, 3/16, 5/14, 5/14	
Average	***0.45, 0.19, 0.38, 0.41***	

Fig. 3. Shapley Marginal Contribution Values

We consider a dynamic resource allocation model where agents arrive at different times and depart similar to Walsh et al. [14]. An agent reports its requirement upon arrival and the demand is accomplished. The requirements do change over time. The water-filling mechanism is a dynamic adaptation of the DRF mechanism [5].

Figure 4 shows our example of allocation of demands based on the modified water filling algorithm. The agent can demand sensors of all modalities based on priority using Shapley value marginal contributions. The Von Neumann-Morgenstern concept of a utility function can be used as an aid to decision making under uncertainty. A decision maker's utility function contains information about their attitude toward risk. Decisions may be risk-averse, risk-neutral, or risk-seeking [15]. Our utility function is as follows:

$$\forall r\ (u_i(A_i) = max\{D_{ir}, S_{ir}\}) \quad (1)$$

where S is the Shapley value marginal contributions. For each modality, the agent is allocated assets for either the maximum of demand or Shapley value. Equation (1) generates a demand vector for each agent and for each modality. Using the Shapley values, for example, the demand vector for the blue (Pakistan) player is [3/5, 1/4, 1/2, 4/9, 5/9, 3/8, 6/13]. Since blue also has the largest Shapley value, blue goes gets first priority tasking allocations. The next player's turn is determined by the Shapley value and so forth. In our example, Pakistan receives sensor assets for all three modalities. Iran receives all three as well with demand vector [1/7, 1/4, 1, 2/11, 4/10, 4/7, 5/14]. Palestine receives only two assets with demand vector [1/3, 2/3, 1/5, 4/9, 3/11, 3/8, 5/14]. Sudan receives only social media sensors with demand vector [1/3, 1/4, 0, 3/10, 1/6, 1/10, 3/16]. Cycle continues as missions are complete and assets are freed.

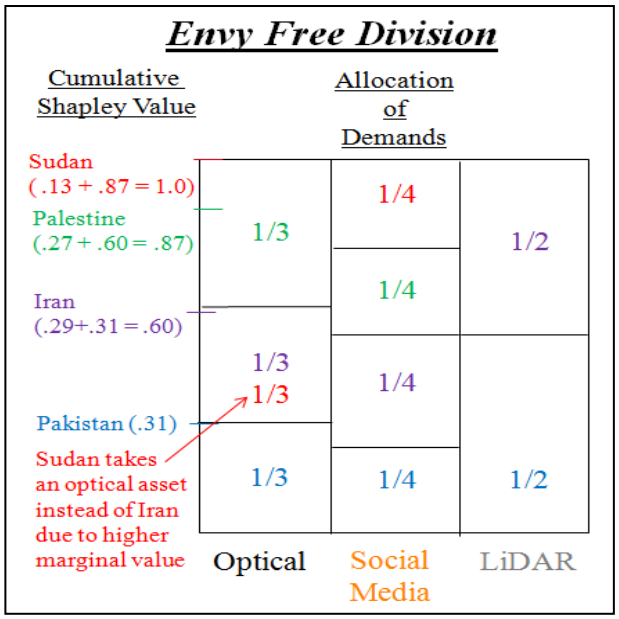


Fig. 4. Water Fill Queuing

The procedure allows for envy freeness. An agent can demand a sensor from another agent as long as it is not allocated or tasked yet. Our process block diagram is shown in Figure 5. Envy freeness means priority is justified mathematically.

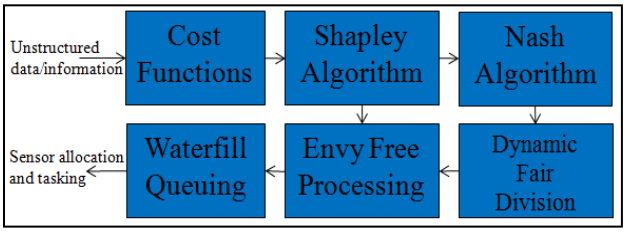


Fig. 5. System Block Diagram

Since Sudan (1/3) has a higher Shapley marginal contribution value for an optical sensor than Iran (1/7), it takes priority. Therefore Iran relinquishes its priority for the optical sensor although it had a higher overall average Shapley value. Figure 5 shows the updated water fill queuing diagram. The incorporation of joint Shapley values comes into play when the agent requests multiple sensor modalities as requirements. When this occurs and there is a possible envy situation, the joint Shapley values are needed. For example, Sudan would not have been able to take an optical asset from Iran player if Iran requested an optical as well as a LiDAR asset. In our example the joint Shapley value for Iran is 4/10 and Sudan is only 1/6. Again the agent with the highest Shapley value has preference for assets.

6. CONCLUSION

We defined a solution for determining strategies based on game theory using our GlobalSite model. Automated game theory is promising for automatically solving real world strategies and helps the warfighter make optimal decisions for resource management and planning activities. Data mining gathers and parses information to allow the user discovery of patterns that are non-obvious and previously unknown. Automated processing techniques are needed to augment tactical intelligence-analysis capabilities by automatically identifying and recognizing patterns.

We discussed the use of reward volumes for solving multi-player games and visualization of a multiplayer payoff matrix. We have identified a novel mathematical application for sensor prioritization by collapsing multi-dimensional problems to use linear programming optimization. Our solution provides the ability to complete a reward matrix from open source data in near real time. We calculate optimal strategies, resource allocation and increases likelihood of best decision available using game theory in a zero or constant sum game.

Finally we discussed a method for modeling asset management with limited resources for multiple sensor modality requirements. One solution is to run the Shapley and Nash algorithms for each successive tasking request and then run a dynamic fair division algorithm to ensure that each request is fair with respect to limited available assets. The motivation for fairness is used to ensure that not all sensor assets are dominated by one agent or player (region of interest). This is needed in order to not miss important events occurring around the world. We realize that solution presented is only a guide and is not intended to replace the human brain in decision making. We offer a user assisted means of prioritization to make agent and resources more effective.

7. REFERENCES

[1] Brandenburger, Adam. "Cooperative Game Theory." *Teaching Materials at New York University* (2007).

[2] Campbell, A. T., Eisenman, S. B., Lane, N. D., Miluzzo, E., Peterson, R. A., Lu, H., ... & Ahn, G. S. (2008). "The rise of people-centric sensing". *Internet Computing, IEEE*, *12*(4), 12-21.

[3] Demers, A., Keshav, S., Shenker, S., "Analysis and simulation of a fair queueing algorithm". In *Proc. Of SIGCOMM*, pages 1–12, 1989.

[4] Diplaris, S., Papadopoulos, S., Kompatsiaris, I., Goker, A., Macfarlane, A., Spangenberg, J., ... & Klusch, M. (2012, April). SocialSensor: sensing user generated input for improved media discovery and experience. In *Proceedings of the 21st international conference companion on World Wide Web* (pp. 243-246). ACM.

[5] Ghodsi, A., Zaharia, M., Hindman, B., Konwinski, A., Shenker, S., Stoica. A., "Dominant resource fairness: Fair allocation of multiple resource types". In *Proc. of 8th NSDI*, pp. 24–37, 2011.

[6] Kash, 1., Procaccia, A., Shah. N., "No agent left behind: Dynamic fair division of multiple resources". In Proceedings of the International Joint Conference on Autonomous Agents and Multi-Agent Systems, 2013.

[7] Kearns, Michael, Michael L. Littman, and Satinder Singh. "Graphical models for game theory." *Proceedings of the Seventeenth conference on Uncertainty in artificial intelligence*. Morgan Kaufmann Publishers Inc., 2001.

[8] Liggins, Hall, Llinas, "Handbook of Multisensor Data Fusion, Theory, and Practice", 2nd Edition, 2009.

[9] Nash, John (1951) "Non-Cooperative Games" The Annals of Mathematics 54(2):286-295.

[10] Rahmes, M., Pemble, R., Lemieux, G., Fox, K., "Multi-Dimensional Reward Volumes for Sensor Priority Strategies", IEEE CCNC 2014 Conference, January 10, 2014.

[11] Rahmes, M., Wilder, K., Fox, K., Pemble, R., "A Game Theory Model for Situational Awareness and Management", IEEE CCNC 2013 Conference, January 11, 2013.

[12] Rahmes, M., Wilder, K., Yates, H., Fox, K., "Near Real Time Discovery and Conversion of Open Source Information to a Reward Matrix", WMSCI 2013, 12 July 2013.

[13] Shapley, L. S. (1953) A Value for n-person Games, in: ''Contributions to the Theory of Games, II,'' H. Kuhn and A. W. Tucker, eds., Princeton: Princeton University Press.

[14] Walsh. T., "Online cake cutting". In *Proc. of 3rd ADT*, pages 292–305, 2011.

[15] Wayne Winston, Operations Research Applications and Algorithms 4th. Edition, 2003.

[16] White, F.E., "Fusion Update: What Will it Take to Make it Work", NDIA Information Dominance Conference, 4 Oct 2010.

[17] www.pewglobal.org; GLOBAL OPINION TRENDS 2002-2007: A RISING TIDE LIFTS MOOD IN THE DEVELOPING WORLD, Sharp Decline in Support for Suicide Bombing in Muslim Countries, JULY 24, 2007.

Program Modeling of the Cryptography Algorithms on Basis of Polynomial Modular Arithmetic

Rustem BIYASHEV
Maksat KALIMOLDAYEV
Nursulu KAPALOVA
Rinat KHAKIMOV
Saule NYSSANBAYEVA

Institute of Informatics and Control Sciences, Ministry of Education and Science
Almaty, 050010, Republic of Kazakhstan

ABSTRACT

The models of software implementation of the system of cryptographic protection of information (SCPI) with the given characteristics are described. This system is intended for using in systems and networks of information transmission and storage. In the created system of cryptographic protection of information, the nonconventional algorithms of encryption and digital signature developed on the basis of nonpositional polynominal notations (NPNs) are implemented. Synonyms of NPNs are notations in residual classes. Given characteristics are the length of the message or the digital signature, as well as cryptostrength of algorithms.

Keywords: cryptography, encryption, digital signature, nonpositional polynominal notations, cryptostrength, residue, software implementation.

1. INTRODUCTION

The well-known algorithms and methods of encryption, digital signature formation schemes and standards are developed in positional notations. The algorithms and methods of cryptography constructed on the basis of algebraic approach proposed by R.G. Biyashev make it possible to considerably increase strength and effectiveness of cryptographic algorithms and to reduce length of hash-values and digital signature [1]. This approach was used in developing and investigation of the method of increasing reliability of stored and processed electronic data. Self-correcting codes with parallel structure developed on the basis of nonpositional polynominal notations and Lagrange (n,k)-codes were used for implementation of this procedure. Basic advantages of these codes include possibility of computational procedure parallelization for increasing of data-handling capacity and improvement of reliability of data processing, storage and transmission procedures.

The report presents the results obtained in the course of development and investigation of the system for cryptographic protection of information for encryption and digital signature algorithms using NPNs.

2. CONSTRUCTION OF NPNS

NPNs synonyms: polynomial notations in residue classes, nonpositional notations and modular arithmetic. Algorithms and methods created on the basis of these systems are also called nonconventional.

In classic residue notation (RN) only positive integers are chosen as a system of base numbers, and a positive integer in such system is presented by its reminders (residues) of division by this system of base numbers [2]. Creation of RN is based on the Chinese remainder theorem use. In accordance with this theorem, representation of a number as a sequence of residues is unique in case base numbers are pairwise relatively primes. In contrast to classic RN in NPNs the irreducible polynomials over the field $GF(2)$, i.e. those with binary coefficients, are used as base numbers [1,3].

Creation of NPNs implies choice of its bases called working bases. Assume that irreducible polynomials

$$p_1(x), p_2(x),..., p_S(x) \qquad (1)$$

are selected as such working bases and let us denote their degrees as $m_1, m_2,..., m_S$ respectively. With allowance for their arrangement, these polynomials (1) form one system of base numbers. The main working range in NPNs is a polynomial

$$P_S(x) = p_1(x)p_2(x)\cdots p_S(x)$$

of degree $m = \sum_{i=1}^{S} m_i$.

In NPNs any polynomial $F(x)$, with the degree less than m, has a unique nonpositional representation in the form of sequence of residues from its division by the base numbers of (1):

$$F(x) = (\alpha_1(x), \alpha_2(x),..., \alpha_S(x)), \qquad (2)$$

where $F(x) \equiv \alpha_i(x) (\mathrm{mod}\, p_i(x))$, i = 1,2,..,S. The positional representation of $F(x)$ is reconstructed from its nonpositional form (2) [1,3]:

$$F(x) = \sum_{i=1}^{S} \alpha_i(x) B_i(x) ,$$

$$B_i(x) = \frac{P_S(x)}{p_i(x)} M_i(x) \equiv 1 (\mathrm{mod}\, p_i(x)) . \qquad (3)$$

Polynomials $M_i(x)$ are selected so that the comparison in representation (3) is satisfied. The formula (3) is used in information processing, storage, and transmission. If only processes of transmission and storage of nonpositional

information are considered, then the positional form of the polynomial $F(x)$ is reconstructed by the formula:

$$F(x) = \sum_{i=1}^{S} \alpha_i(x) P_i(x), \quad P_i(x) = \frac{P_S(x)}{p_i(x)}. \qquad (4)$$

In [1] the arithmetic of nonpositional notations with polynomial bases and its applications to the problems of increase of reliability were developed. It is demonstrated that polynomial algebra over some field modulo polynomial irreducible over this field is a field, and representation of the polynomial in the form (2) is unique (similar to Chinese remainder theorem for polynomials). The rules of arithmetical operations executing in NPNs and reconstructing of polynomial by its remainders were defined too. According to the Chinese remainder theorem, all working base numbers must be different.

Nonconventional cryptosystems were developed for electronic messages of a length with a given number of bits. In NPNs a message (or its block) of a given length N bits is interpreted as a sequence of remainders of division of some polynomial (let us denote it as $F(x)$) by working base numbers (1), i.e. in view of (2). Remainders $\alpha_1(x), \alpha_2(x),..., \alpha_S(x)$ are selected in the way where binary coefficients of reminder $\alpha_1(x)$ correspond to the first l_1 bits of the message, the binary coefficients of reminder $\alpha_2(x)$ correspond to the next l_2 bits, etc., and binary coefficients of reminder $\alpha_S(x)$ correspond to the last l_S binary bits.

Each working base number should have a degree not exceeding N value. These base numbers are selected from all irreducible polynomials with degrees varying from m_1 to m_S, provided that the following equation [4] is satisfied:

$$k_1 m_1 + k_2 m_2 + ... + k_S m_S = N. \qquad (5)$$

In equation (5), $0 \le k_i \le n_i$, i = 1,2,..,S are unknown coefficients and number of selected irreducible polynomials of degree m_i, one certain set of these coefficients is one of the solutions to Eq. (5) and specifies one system of working base numbers, n_i is a number of all irreducible polynomials of degree m_i, $1 \le m_i \le N$, $S = k_1 + k_2 + ... + k_S$ is a number of selected working base numbers. Complete residue systems modulo polynomials of degree m_i include all polynomials with the degree not exceeding m_i-1, and whose representation requires m_i bits. With increasing degrees of irreducible polynomials, their number rapidly increases (Table 1), and, as a result, the number of solutions to Eq. (5) considerably increases.

The properly checked table of irreducible polynomials over field $GF(2)$ for the degrees shown in Table 1 was published in No. 1 of "Proceedings of KAHAK technical society" (2013, Almaty, Republic of Kazakhstan).

3. ALGORITHM OF SYMMETRIC ENCRYPTION

In nonconventional encryption algorithm of electronic message of a given length equal to N bits, the encryption procedure is preceded by two other stages. First NPNs are formed by choosing the system of polynomial base numbers and the order of their disposition. Then key (pseudorandom) sequence is generated.

Stage 1 is described in section 2.

Stage 2. The used key sequence with length equal to N bits is interpreted in the same way as the sequence of remainders $\beta_1(x), \beta_2(x),..., \beta_S(x)$ of division of some other polynomial $G(x)$ with respect to the same working base numbers of the system:

$$G(x) = (\beta_1(x), \beta_2(x),..., \beta_S(x)), \qquad (6)$$

where $G(x) \equiv \beta_i(x) (\mathrm{mod}\, p_i(x))$, i=1,2,..,S. Then any encryption function $H(F(x), G(x))$ may be considered as a cryptogram $\omega_1(x), \omega_2(x),..., \omega_S(x)$:

$$H(x) = (\omega_1(x), \omega_2(x),..., \omega_S(x)), \qquad (7)$$

where $H(x) \equiv \omega_i(x) (\mathrm{mod}\, p_i(x))$, i = 1,2,..,S.

In concordance with the execution of NPNs operations the operations in the functions $F(x)$, $G(x)$, $H(x)$ are executed in parallel according to modulo of polynomials (1) chosen as NPNs working base numbers.

Table 1. Dependence of number of irreducible polynomials on their degree

Degree of Irreducible Polynomials	Number of Irreducible Polynomials
1	1
2	1
3	2
4	3
5	6
6	9
7	18
8	30
9	56
10	99
11	186
12	335
13	630
14	1161
15	2182
16	4080

Key length is one of the system strength indicators. In nonconventional encryption the strength of cryptographic algorithm characterized by complete (private) key is used as a cryptostrength criterion. In this algorithm a complete key is the polynomial $G(x)$ and the certain set of working base numbers chosen from the set of irreducible polynomials whose degree does not exceed N.

Statement 1. The cryptostrength of an encryption algorithm developed on the basis of NPNs is determined by total number of possible and distinct from each other variants of choice of key sequences and systems of working base numbers.

To prove the above fact, the combination number of choice of base numbers for each base number degree determined by the equation (5) is calculated. Then the number of

combinations of system forming from S base numbers with the degrees $m_1, m_2, ..., m_S$ with allowance for their arrangement is determined by expression $(k_1 + k_2 + ... + k_s)!\ C_{n_1}^{k_1} C_{n_2}^{k_2} \cdots C_{n_S}^{k_S}$. The encryption is performed by imposing on the message of the generated key sequence of the same length N bits. Therefore for encryption the choice of one system from S base numbers is defined by the formula:

$$2^N\ (k_1 + k_2 + ... + k_s)!\ C_{n_1}^{k_1} C_{n_2}^{k_2} \cdots C_{n_S}^{k_S}\ . \qquad (8)$$

Then the encryption cryptostrength of the message of length N bits is determined as the inverse value for (8):

$$p_{kr} = 1/(2^N \times \sum_{k_1,k_2,...,k_S} (k_1 + k_2 + ... + k_s)! \times$$

$$\times\ C_{n_1}^{k_1} C_{n_2}^{k_2} \cdots C_{n_S}^{k_S}\ ). \qquad (9)$$

In expression (9) the summation is performed over all possible combinations of coefficients $k_1, k_2, ..., k_S$, satisfying the equation (5).

Non-traditional method in which the elements of the sequence of residues $\omega_1(x), \omega_2(x), ..., \omega_S(x)$ in the cryptogram are the smallest remnants of division of products $\alpha_i(x)\beta_i(x)$ by respective bases $p_i(x)$ is used for encryption if multiplication operation is used as the function $H(F(x), G(x))$ [5]:

$$\alpha_i(x)\beta_i(x) \equiv \omega_i(x) (\mathrm{mod}\ p_i(x))\ ,\ i=1,2,...S. \qquad (10)$$

For deciphering cryptogram $H(x)$ by the known key $G(x)$ for each value $\beta_i(x)$ the calculation of the reverse (inverse) polynomial $\beta_i^{-1}(x)$ is made as follows from (10) provided that the following equation is satisfied:

$$\beta_i(x)\beta_i^{-1}(x) \equiv 1 (\mathrm{mod}\ p_i(x))\ ,\ i=1,2,...S. \qquad (11)$$

The result is the polynomial $G^{-1}(x) = (\beta_1^{-1}(x), \beta_2^{-1}(x), ..., \beta_S^{-1}(x))$ inverse to the polynomial. Then the elements of the sequence of residues (2) in accordance with (10) and (11) are restored as compared with:

$$\alpha_i(x) \equiv \beta_i^{-1}(x)\omega_i(x) (\mathrm{mod}\ p_i(x))\ ,\ i=1,2,...S.$$

Thus, in the present model of the encryption algorithm of electronic message of the specified length N bits in NPNs, the complete key is:

- the chosen system of polynomial working bases $p_1(x), p_2(x), ..., p_S(x)$;
- the key $G(x) = (\beta_1(x), \beta_2(x), ..., \beta_S(x))$;
- the key $G^{-1}(x) = (\beta_1^{-1}(x), \beta_2^{-1}(x), ..., \beta_S^{-1}(x))$ needed for deciphering and inverse to $G(x)$.

Examples of determination of cryptostrength by the formula (9).

1. Key length equals 100 bits: system of base numbers includes 6 irreducible polynomials of degree 16 and 1 irreducible polynomial of degree 4. S=7. For this system of base numbers we obtain $p_{kr} \approx 10^{-53}$.

2. Key length equals 200 bits: system of base numbers includes 12 irreducible polynomials of degree 16 and 1 irreducible polynomial of degree 8. S=13. $p_{kr} \approx 10^{-106}$.

3. Key length equals 128 bits: system of base numbers includes 8 polynomials of degree 16. S=8. $p_{kr} \approx 10^{-69}$.

4. Key length equals 256 bits: system of base numbers includes 16 polynomials of degree 16. S=16. $p_{kr} \approx 10^{-135}$.

The State Standard of the Republic of Kazakhstan ST RK 1073-2007 specifies the 1st, 2nd, 3rd and 4th security levels for the means of cryptographic protection of information. Key length of symmetric algorithms for these levels should be at least 60, 100, 150 and 200 bits respectively [6]. Minimum cryptostrength values for the keys of 100 and 200 bits equal to $2^{-100} \approx 10^{-29}$ and $2^{-200} \approx 10^{-60}$, respectively. As is seen from examples 1 and 2, the cryptostrength of nonconventional encryption is by tens of orders greater.

Thus, use of NPNs in creation of symmetric encryption algorithms help to achieve the required levels of reliability specified by the Standard ST RK 1073-2007 with significantly shorter secret key lengths. Nonpositional nature of notations also helps to provide high performance and prevent propagation of errors.

4. ALGORITHM FOR FORMATION DIGITAL SIGNATURE MODULO SEVERAL REDUNDANT POLYNOMIAL BASE NUMBERS

Algorithm proposed for formation of a digital signature of length N_k bits for an electronic message of a given length equal to N bits in NPNs includes three stages. The developed algorithms differ by redundancy introduction procedures at the second stage.

Stage 1. Creation of NPNs.

Stage 2. Hashing (compression) of a message from length N to length N_k ($N_k << N$) by extrapolation on the redundant (extension) base numbers. This procedure is performed through expansion of NPNs on the redundant base numbers

$$p_{S+1}(x), p_{S+2}(x), ..., p_{S+U}(x)\ . \qquad (12)$$

These base numbers are selected from all irreducible polynomials whose degree does not exceed N_k. The system of redundant base numbers (12) is formed independently from the system (1), but among redundant base numbers there may be some that are similar to several working base numbers.

Then the redundant residues $\alpha_{S+1}(x), \alpha_{S+2}(x), ..., \alpha_{S+U}(x)$ are calculated from division of the polynomial $F(x)$ reconstructed from the formula (4) by redundant base numbers. In this case the hash-value is interpreted as a sequence of such residues:

$$h(F(x)) = (\alpha_{S+1}(x), \alpha_{S+2}(x), ..., \alpha_{S+U}(x))\ ,$$

where $h(F(x)) \equiv \alpha_{S+j}(x)(\mathrm{mod}\, p_{S+j}(x))$, $j = 1,2,..,U$. The sum of redundant residues lengths equals to the length of hash-value.

Stage 3. Encryption of the obtained hash-value. It is performed by algorithm on the basis of NPNs. NPNs parameters are described by expressions similar to expressions (1), (2) and (5). For this purpose the system of base numbers $r_1(x), r_2(x),..., r_W(x)$ is chosen from irreducible polynomials whose degree does not exceed N_k. Composition of these base numbers may include some polynomials from working and redundant base numbers.

Then the hash-value is interpreted as the remainder sequence $\gamma_1(x), \gamma_2(x),..., \gamma_W(x)$ in division of some polynomial $F_1(x)$ by chosen base numbers $r_1(x), r_2(x),..., r_W(x)$ respectively:

$$F_1(x) = (\gamma_1(x), \gamma_2(x),..., \gamma_W(x)),$$

where $F_1(x) \equiv \gamma_j(x)(\mathrm{mod}\, r_j(x))$, $j = 1,2,..,W$. The key of length N_k is generated and interpreted as the remainder sequence $\eta_1(x), \eta_2(x),..., \eta_W(x)$ in division of some polynomial $G_1(x)$ by base numbers $r_1(x), r_2(x),..., r_W(x)$:

$$G_1(x) = (\eta_1(x), \eta_2(x),..., \eta_W(x)),$$

$$G_1(x) \equiv \eta_j(x)(\mathrm{mod}\, r_j(x)), \quad j = 1,2,..,W.$$

Therefore the obtained cryptogram $\lambda_1(x), \lambda_2(x),..., \lambda_W(x)$ is any function $H_1(F_1(x), G_1(x))$:

$$H_1(x) = (\lambda_1(x), \lambda_2(x),..., \lambda_W(x)),$$

where $H_1(x) \equiv \lambda_j(x)(\mathrm{mod}\, r_j(x))$, $j = 1,2,..,W$.

Digital signature check. After obtaining a signed message the addressee calculates two hash-values. The first hash-value is determined from the obtained message. The second hash-value is determined as a result of deciphering the obtained digital signature. If the values of these hash-values coincide, then the signature is authentic.

The complete key of this algorithm includes systems of working and redundant base numbers with consideration of their order and the complete key of hash-value encryption.

Statement 2. The cryptostrength of nonconventional algorithm for forming a digital signature modulo several redundant base numbers is determined by total number of all possible and distinct from each other variants of choice of the systems of working and redundant base numbers, key sequences and the systems of base numbers for encryption of hash-value.

Therefore in developing the cryptostrength formula all possible means of choosing base numbers are determined at each stage of digital signature formation.

Stage 1. The total number of different systems out of S chosen base numbers of certain degrees $m_1, m_2, ..., m_S$ will be determined by the expression:

$$(k_1 + k_2 + ... + k_S)!\ C_{n_1}^{k_1} C_{n_2}^{k_2} \cdots C_{n_S}^{k_S}. \qquad (13)$$

Stage 2. The degree and the number of irreducible polynomials used in choosing redundant base numbers are denoted as $a_1, a_2, ..., a_U$ and $d_1, d_2, ..., d_U$, respectively. The number of chosen redundant base numbers is determined from the analogue of the equation (5): $t_1 a_1 + t_2 a_2 + ... + t_U a_U = N_k$. Here $0 \le t_j \le d_j$ is the number of chosen redundant base numbers with degree a_j, $1 \le a_j \le N_k$, $j = 1,2,..,U$, $U = t_1 + t_2 + ... + t_U$ is the number of redundant base numbers of the system, whose residue records cover hash-value of length N_k. All possible variants of choice of such redundant base numbers systems are defined by expression:

$$\sum_{t_1,t_2,...,t_U} (t_1 + t_2 + ... + t_U)!\ C_{d_1}^{t_1} C_{d_2}^{t_2} \cdots C_{d_U}^{t_U}. \qquad (14)$$

The summation here is performed over all possible combinations of redundant base number systems choice. All variants of redundant base number systems choice will be obtained in joint performance of operations of choice of the systems of S working and U redundant base numbers, i.e. from the product of the expressions (13) and (14).

Stage 3. For hash-value encryption the system of base numbers $r_1(x), r_2(x),..., r_W(x)$ is selected. Let us denote the degree and number of irreducible polynomials used for their choice as $b_1, b_2,..., b_W$ and $l_1, l_2,..., l_W$ respectively. The choice is based on meeting the conditions of the analogue of the equation (5): $v_1 b_2 + v_2 b_2 + ... + v_W b_W = N_k$. In this equation $0 \le v_j \le l_j$, $j = 1,2,..,W$ are unknown coefficients or the number of chosen base numbers with degree b_j, $1 \le b_j \le N_k$, $W = v_1 + v_2 + ... + v_W$. For all variants of choice of systems from W base numbers and key sequence we obtain the expression:

$$2^{N_k} \sum_{v,v_2,...,v_W} (v_1 + v_2 + ... + v_W)! \times \times C_{l_1}^{v_1} C_{l_2}^{v_2} \cdots C_{l_W}^{v_W}. \qquad (15)$$

With consideration of the expressions (13) to (15) we obtain the expression for determination of cryptostrength of digital signature generation algorithm:

$$p_{sig} = 1/[2^{N_k} \sum_{k_1,k_2,...,k_s} ((\,(k_1 + k_2 + ... + k_s)! \times \times C_{n_1}^{k_1} C_{n_2}^{k_2} \cdots C_{n_S}^{k_S} \sum_{t_1,t_2,...,t_U} (t_1 + t_2 + ... + t_U)! \times \times C_{d_1}^{t_1} C_{d_2}^{t_2} \cdots C_{d_U}^{t_U}\,) \sum_{v,v_2,...,v_W} (v_1 + v_2 + ... + v_W)! \times \times C_{l_1}^{v_1} C_{l_2}^{v_2} \cdots C_{l_W}^{v_W}\,)]. \qquad (16)$$

In the expression (16) external summation is performed over all possible choices of S working base number systems from the number of irreducible polynomials with degree not exceeding N value.

Example of determining the cryptostrength by formula (16). The length of the signed electronic message equals 256 bits. The system of working base numbers: 16 irreducible polynomials of degree 16. S=16. The signature length equals 100 bits. The system of redundant base numbers: 6 irreducible polynomials of degree 15 and 1 irreducible polynomial of degree 10. U = 7. To encrypt the hash value the following system of base numbers is chosen: 6 irreducible polynomials of degree 16 and 1 irreducible polynomial of degree 4. W = 7. For this version of choice of base numbers at each stage of the digital signature formation $p_{sig} \approx 10^{-133}$.

The obtained data is the proof of reliability of nonconventional algorithm. Creation of signature with significantly smaller length than that specified in the standard ST RK 1073-2007 is possible, and cryptostrength of digital signature may be the same or even higher [6].

5. THE SYSTEM FOR CRYPTOGRAPHIC PROTECTION OF INFORMATION

The system of cryptographic protection of information will be the result of program realization of the presented cryptographic algorithms. This system is a complex of computer programs which will consist of three interconnected blocks: the formation of complete secret keys (further – complete keys), the system of encryption and the digital signature scheme. When modeling the system of cryptographic protection of information, the processes of generation and storage of complete keys for encryption and calculation of the digital signature are the basic ones. Storage of these keys is carried out in different databases. In the subsystem of formation of complete keys "Formation of complete keys" the following procedures are realized:
1. calculation and preservation of irreducible polynomials of the given degree with binary coefficients;
2. definition of structures of databases of the complete keys for systems of encryption and digital signature;
3. formation and storage of complete keys in a database for each cryptosystem.

In "The system of encryption" block the main modules are:
- choice of the complete secret key by the given encryption cryptostrength;
- encryption of a message of the given length N bits;
- decryption of a cryptogram.

"The digital signature scheme" block forms the signature of length N_k for the electronic message of the given length N bits and includes the following procedures:
- choice of the complete key by the given cryptostrength of the signature formation algorithm;
- calculation of the digital signature;
- verification of the digital signature.

Databases of irreducible polynomials and complete keys are used in program modules of encryption and formation of the digital signature. The systems of base numbers for creation of nonpositional polynomial notations and calculation of complete keys of various length will be chosen from the database of irreducible polynomials. The found components of complete keys of systems for encryption and digital signature are wrote in the corresponding databases.

Two models of SCPI creation are offered. The distinction of these models consists in different ways of the complete key choice, that is where and how the cryptostrength of the chosen key with the given cryptostrength is checked. In accordance with it, different models of implementation of nonconventional cryptoalgorithms are defined.

In the first SCPI model the cryptostrength is defined directly in program modules implementing the systems of encryption and digital signature. In this case there are no values of their cryptostrength in databases of complete keys.

In the first model of the encryption block the cryptostrength of the chosen complete key is calculated in the same block. In the program encryption module, the choice of the system of working bases, generation of pseudorandom sequence for receiving $G(x)$ key [7], cryptostrength calculation by formula (9) and its assessment for the chosen system of bases and encryption of an electronic message of the given length are made. Calculation and assessment mean that the value of the chosen key cryptostrength has to be not less than the value of the given cryptostrength. In the program decryption module, the received cryptogram is deciphered with the use of the inverse $G^{-1}(x)$ key.

The first model of the digital signature scheme - the choice of systems of working and redundant bases and bases for hash - value encryption is made from the database of irreducible polynomials. The cryptostrength which is compared to the given one is calculated by the chosen base systems. If the value calculated by the formula (16) turns out to be more than the given cryptostrength, other base systems will be chosen. When the necessary set of base systems is found, the digital signature by means of encrypting the received hash - value is calculated.

The advantage of the considered SCPI model lies in the fact that the complete key is formed and chosen at the time of cryptoalgorithm performance. This model allows to provide considerable privacy of the used complete keys, but under these conditions the speed reduction of procedures of encryption or formation of the digital signature is possible. The speed can be increased at the expense of parallelization of computing operations in all bases used in the realized cryptoalgorithm.

In the second SCPI model, the complete key for systems of encryption and calculation of the digital signature is formed in the "Formation of complete keys" block with the use of database of irreducible polynomials. The received complete key is preserved in the corresponding database. The value of cryptostrength of systems of encryption and formation of the digital signature which is registered in the corresponding database is also calculated in this SCPI model for each formed complete key. Besides all the components of the complete key, other secret information can be stored in the database, too. The advantage of the second SCPI model is the possibility of reserve creation of complete keys of different length. Databases of complete keys will be protected. Therefore, they will be stored in the encrypted form and also have reserve copies.

Calculation of cryptostrength is made for the second model of encryption realization in the "Formation of complete keys" block. Then the database of complete keys is supplemented with values of cryptostrength calculated by the formula (9) for each system of the working bases. In this case, such complete key of encryption is chosen from the database so that its cryptostrength won't be less than the given one.

The encryption speed in the first model of the encryption block can be lower than in the second one, but its advantage

consists in uniqueness of the chosen complete key. Efficiency of the first model can be raised at the expense of hardware-software realization.

In the second model of the digital signature scheme, the complete key also will be chosen in the "Formation of complete keys" block (respectively, by message and digital signature lengths) and will be stored in the database of complete keys. The components of the complete key are the system of working bases, the system of redundant bases, and also the system of bases, the pseudorandom sequence (the traditional secret key), and the inverse for pseudorandom sequence key for hash-value encryption . Then the value of cryptostrength for systems of complete keys will be calculated which will be wrote in the corresponding database.

6. CONCLUSIONS

Using NPNs in development of algorithms of symmetric encryption and digital signature formation allows to increase their cryptostrength. It is possible to significantly increase the effectiveness of these algorithms at the expense of parallel performance of operations modulo base numbers of used NPNs.

The creation of two models of the system of cryptographic protection of information is conditioned by construction of flexible and, if needed, simply transformed SCPI. Availability of various program modules of creation of complete secret key databases will allow to implement different models of encryption and digital signature systems on the basis of NPNs. Works on development, analysis and realization of domestic means of cryptographic information security for the Republic of Kazakhstan are actual as Kazakhstan is actively integrated into the world information community.

7. REFERENCES

[1] R.G. Bijashev, **Development and investigation of methods of the overall increase in reliability in data exchange systems of distributed ACSs**, Moscow: Doctoral Dissertation in Technical Sciences, 1985.

[2] I.Ya. Akushskii and D.I. Juditskii, **Machine Arithmetic in Residue Classes** [in Russian], Moscow: Sov. Radio, 1968.

[3] R.G. Bijashev and S.E. Nyssanbayeva, "Algorithm for Creation a Digital Signature with Error Detection and Correction", **Cybernetics and Systems Analysis**, Vol. 48, No 4, 2012, pp. 489-497.

[4] Gr.C. Moisil, **Algebraic Theory of Discrete Automatic Devices** [Russian translation], Moscow: Inostr. Lit., 1963.

[5] R.K. Nyssanbayev, "Cryptographical method on the basis of polynomial bases", **Herald of the Ministry of Science and Higher Education and National Academy of Science of the Republic of Kazakhstan**, No. 5, 1999, pp. 63-65.

[6] ST RK 1073-2007 **"Means of cryptographic protection of information. General technical requirements"**, Astana: 2009.

[7] N.A.Kapalova and S.E. Nyssanbayeva, "Analysis of statistical properties of algorithm of generation of pseudorandom sequences", **Materials of the X-th International scientific-practical conference "Information security", P. 2.**, Taganrog: TIT SFU Publishing house, 2008, pp. 169-172.

Analysis of a New Information Society Paradigm and e-Government Development Model: Based on Korea's E-Government Practices

Seang-Tae Kim
Graduate School of Governance, Sungkyunkwan University
Seoul, Republic of Korea

ABSTRACT

The history of humankind has sped on past the industrial society and is now on the verge of transitioning from the information society to the highly-advanced information society. Based on the development of information technology, degree of social pluralism, and the maturity of civic society, this study provides as new e-Government development models, the bureaucratic e-Government, information management-centered e-Government, participatory e-Government, and governance-type e-Government models. It also attempts to analyze in diachronic terms the four new e-Government development models by applying Korea's cases of e-Government implementation. As the top-priority tasks for the highly-advanced information society to mature, this paper provides five strategies – transforming into a 'platform-type government' for open government operation, utilization of social networks based on creativity and collective intelligence of the private sector, disclosure and sharing of public information, facilitation of smart work, and preparation of measures against the adverse impact of informatization regarding information security and personal information protection.

Keywords: e-Government; Highly-advanced Information Society; New e-Government Development Model

INTRODUCTION

Influenced by the global ripple effect from the release of iPhone in 2009 and with new information technologies spreading through in form of social networks such as the Facebook and Twitter, Korea also has witnessed a rapid development of the new highly-advanced information society, which led to great influence and change to our social spheres such as politics, administration, economy and culture, and also to our daily lives.

Especially, the government is improving to a partnership-based framework upon which individuals and the government are working together beyond bilateral participation. Demands are also increasing for e-government services to comply with the new changes in interactive services on social networks.

However, academic research on such smart technologies and social changes is non-existent, if not very weak in that only part of technological or social changes is taken to show and discuss fragmentary effect or influence.

From the comprehensive viewpoint embracing both technological and social paradigms while overcoming fragmentary thinking and difference in views, this study aims to propose a new e-government development model based on the paradigm shift in the highly-advanced information society and to explain the changes in e-government level and services and diagnose the current status by applying Korea's e-government practices in a time-series based on the new development model.

This is expected to contribute a lot in terms of academic research on e-government, along with benefits in other terms such as spread ability and applicability of the highly-advanced information society to other advanced countries and capability to develop alternative policy measures like solving adverse effects, for Korea has faster IT receptive capacity than other countries and has well-established wired and wireless Internet environment such as the broadband network.

This paper discusses the social paradigm shift, changing government roles and literature review in the following two sections and introduces the analytic framework and methodologies in section 3. Section 4 introduces application and verification of the development model in Korea's practices, and section 5 provides the conclusion and policy implications.

SHIFTS IN HIGHLY-ADVANCED INFORMATION SOCIETY PARADIGM AND GOVERNMENT ROLES

Social paradigm shift and changing government Roles

The history of human society has been marked by paradigm shifts caused by technological advances, changes in social values, and other core driving factors (Keely, 2007). In the agricultural society, a variety of methods were developed using the basic human labor to overcome natural disasters, thereby placing physical industriousness first among all other required qualities. The industrial revolution shifted the human history from the agricultural society to the industrial society. In the industrial society, technicians or skilled factory workers emerged as indispensable and under the uniform bureaucracy, these workers were forced to bear an enormous amount of labor hours. Such society, again, evolved to the information society, where the emergence of computers and communications technology led to increased significance on knowledge and information. A wide variety of knowledge and information became the core resources in the information society, while opening and sharing such resources became important social values (Drucker, 2002).

The need and strategy for preparing for the advanced information society have been recently discussed. Don Tapscott (2011) explained that the emergence of the N-generation grown up in the digital environment brought macro-wikinomics, which is the age of innovation based on collaboration and openness, or the age of networked collective intelligence.

Beccalli-Falco in GE (2011) announced that the age of smart revolution has arrived, which connects and integrates the innovative technologies in the human history such as the invention of electricity, telephones, TVs and computers. In

order to overcome the global financial crisis, Samuel J. Palmisano, then President and CEO of IBM (2008), advocated 'Smarter Planet' in the hope of making a better world in terms of energy, traffic, finance and city management by connecting humans and the environment via intelligent and networked devices or by networking various different systems. Yoon Bu-Keun, CEO of Samsung Electronics (2009) proposed, as a new paradigm, achieving digital humanism that inspires technologies with the values and emotions that naturally belong to humans.

Compared to the past information society, the highly-advanced information society can be characterized by more efficient, productive and economical social systems and processes, which are enabled by smart technologies. In addition to such increased efficiency and productivity, this society highly respects human dignity and creates values through combining technologies and other various sectors.[1]

The features that make up the future societies, including the highly-advanced information society; they can be summarized as the shift toward human-oriented values such as the emergence of smart society, collective intelligence, and open access, as scholars have stressed.

The roles and functions of governments evolve in response to the constantly changing administrative and technological environment. The evolution of IT such as the Internet, in particular, is changing the roles of the government and other public sector as well as the service provision paradigm as a whole. From the government as a 'manager' that emphasizes on legitimacy, supervision, control and efficiency, to a 'decision-maker' that focuses on disclosure, sharing and bilateral participation while making policies, and further to a 'value-creator' that stresses communication, sharing, collaboration and integration while settling conflicts and mediating different views among interest groups, the government position and roles are changing toward those of a citizens' partner.

In time, with further progress in informatization and democratic development, government websites came to be used as convenient channels of communication between the government and citizens. Citizens were not only informed of government policy undertakings and news, but they also provided feedback. They submitted their ideas and proposals while voicing complaints and addressing issues through the various government websites. By facilitating citizens' participation in public issues and government affairs, electronic media made considerable contributions toward the advancement of democracy in Korea. More recently, the concepts of Web 3.0 focusing on the personalized and customizable values and Government 2.0 Movement focusing on the social network, communication and openness are even more facilitating government interaction with the citizens and the maturity of citizen participation. Government 2.0 Movement is a new cultural initiative based in Australia, UK, and US, which calls for disclosure of the government's decision-making and enforcement process by using web 2.0 technologies, therefore leading to active participation of citizens in the process(James Gardner, et. al, 2012).

Preceding studies on theories for e-government development stages

Methodologies for categorizing e-Government by developmental stages can vary – there can be three, four, five or more than six stages and they can differ based on scholars such as Kauver or Moon, on business consulting institutions such as Deloitte or Gartner, on international organizations such as UN or OECD and on technologies or participation.

Here, we use three categorization methods – development based on the Web or Internet, development based on citizen participation, and development based on government innovation or services.

First of all, there is the set of developmental stages categorized based on the Web or the Internet - This method can be represented by the UN study, in which UN came up with five stages of e-Government evolution – emerging, enhanced, interactive, transactional, and connected – while assessing the e-Government readiness, based on how efficiently government websites express and deliver government services and information. In the 'connected' stage, the most sophisticated level, government services are requested, processed and delivered in a seamless manner, through entirely networked and integrated government organizations using web technologies. Studies by Deloitte Research (2000), Moon Shin-Yong (2001) and Cho Duk-Ho et. al. (2002), West (2004) also fit in here using this method.

The second method is categorization based on government innovation and services, as represented by the OECD study (2003). Using the model of the Australian National Audit Office, OECD categorized the e-Government into four stages according to service type or quality – they are stages of simple information provision, information provision through interaction between the government and citizens, transaction, and information sharing. It is reported that in the stage of information sharing, the most sophisticated level, simplified public administration innovates the process and at the same time increases efficiency, further leading to decrease of citizens' application procedures for government services. Besides the OECD study, this method includes studies by Kauver (1998), Layne & Lee (2001), Yoon Sang-Oh (2003), Siau & Long (2005), etc.

The third method is based on citizen participation and this is used in studies by Gartner (2000), Hiller & Belanger (2001), Reddick(2005), etc. Ramsey of IBM (2004) classified digital government into four stages or 'waves' – i) putting existing services online; ii) developing portals from the basic to the sophisticated; iii) simplifying regulations and services through information integration; and iv) government transformation – according to the ultimate goal that the government plans to achieve. The customized government achieved from government transformation offers the most integrated stage of digital government in both horizontal and vertical terms, encompassing integration of the entire value chain from internal businesses to external customer affairs toward procurement suppliers, private-sector partners and the general public.

[1] I use the term 'highly-advanced information society' as having the same meaning as the 'smart society', which is explained in detail in "Korea's Future Strategy toward the Smart Society (2011)'. In the paper, the two terms shall be used as the same.

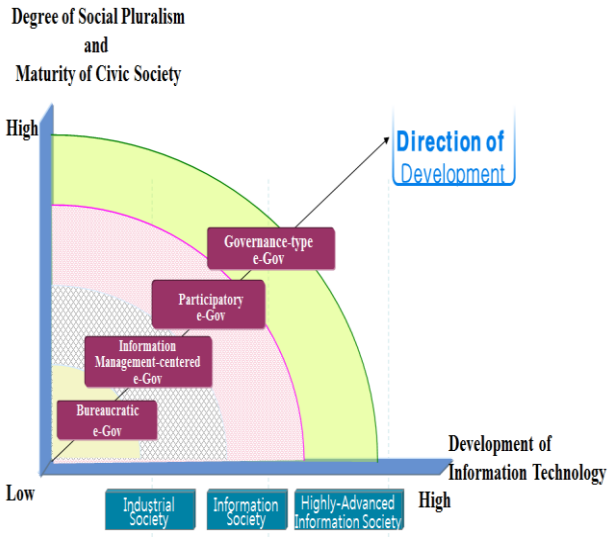
ANALYSIS FRAMEWORK FOR THE STUDY

Many studies on e-government development stages in the past have limitations in that they often deal with only part of e-government development, rather focuses on evaluation of some representative websites that are officially exposed, or recognizes the development model as a fixed framework that is unchangeable.

In this regard, a new e-government development model is suggested to comprehensively understand the technologies, services and citizen participation. The new model classifies e-government into 'bureaucratic', 'information management-centered', 'participatory' and 'governance-type' by identifying the development stages based on the social paradigm shift such as the industrial, information, and highly-advanced information societies on one hand, and identifying the changes in government roles based on the level of social pluralism and civic society maturity, both of which make up the e-government democracy, on the other hand.

The new model classifies e-government by identifying the changes in government roles based on the level of social pluralism and civic society maturity on one hand, both of which are related to e-Democracy, and identifying the development stages based on the social paradigm shift on the other hand. In terms of social paradigm shift, Korea has undergone more compact growth time-wise compared to the United States and other EU countries. Whereas the United States and EU countries have taken as long as 2 centuries to come through modernization, industrialization and informatization, Korea, since its independence in 1945, experienced the industrial society during the 1970~1980s and has entered the information

Figure 1. Analysis Framework: E-Government Development Model Based on Social Paradigm Shift



society, which is an amazing growth in such a short time of 40~50 years.

In <Figure 1>, the horizontal axis shows social paradigm shift related with IT development. Along the vertical axis are the varying levels of social pluralism and civic maturity from low to high and these levels can be classified in relation to features of e-Democracy as follows. [2]

The types of e-Government suggested here are based on the conceptual model of e-Government, which can be classified according to shifting social paradigm as follows:

The first stage is bureaucratic e-Government. This is a stage where e-Democracy is within the bureaucratic system under a very low level of social pluralism and passive civic society. In this stage, attempts are made to apply e-Democracy only to the process of decision-making within government organizations.

The second stage is information management-centered e-Government. This is a stage that can be found under a low level of social pluralism and still rather passive civic society. This stage emphasizes information disclosure to government organizations and the civic society, though in a passive way, and citizens' right to know.

The third stage is participatory e-Government. This stage can be found in an active civic society with a significant level of social pluralism. This stage focuses on facilitation of information disclosure from within government organizations to citizens and active participation of citizens in government decision-making. Bilateral communication between the government and citizens is also facilitated in this stage.

The fourth stage is governance-type e-Government. This is a stage with a very high level of social pluralism and can be found in a very active civic society. Not only government organizations but also various members of the society exchange information with each other through electronic communication means and influence transparent and democratic decision-making, all of which further facilitate communication network throughout the entire society. The governance-type e-Government is widespread in the highly-advanced information society.

In this study, attempts are made to analyze major projects and services for each stage by applying them to Korea's cases based on the e-Government development model. The time scope of this study is from the early 1990s when the term e-Government was first used in Korea and abroad to President Lee Myung-Bak administration, and the scope covers projects for bureaucratic, information management-centered, participatory, and governance-type e-Government.

ANALYSIS OF KOREA'S CASES BASED ON APPLICATION OF E-GOVERNMENT DEVELOPMENTAL STAGES

This study attempts to analyze the e-Government cases of Korea with the aim of classifying them into the bureaucratic, information management-centered, citizen participatory, and governance-type models.

Application of bureaucratic e-government model:

[2] The "Shift in Social Paradigm and e-Government Paradigm" is newly created, by reflecting the social change paradigm in the Relation Pattern of Electronic Democracy and e-Government (Kim, S. T., 2003). See Kim, S. T. (2005) for the concept definition and more details of the Relation Pattern of Electronic Democracy and e-Government.

establishment of the initial infrastructure for computerizing government affairs

The first time the term e-Government was used in Korea was around 1995, and along with the widespread use of the term, full-scale e-Government projects also started around this time. In the first place, a framework system to take full control in information and communications affairs. The Post Office was expanded and founded as the Ministry of Information and Communication and the Framework Act on Informatization Promotion was also first enacted around this time to provide the blueprint of informatization throughout Korea every five years. Upon such legal base, the 1st Master Plan for Informatization Promotion was established in 1996, which set as its first project, 'achieving small, yet efficient e-Government'. This was the first time in Korea that an e-Government policy was adopted as the national strategy. Some scholars as well as researchers in National Computerization Agency had used the term 'e-Government' around 1995 in their studies and research papers by quoting cases of other countries like the United States.

Some of the projects include the construction of the national backbone networks regarding five areas that make up the national operation framework including government administration, finance, education and research, national defense and security. The information super-highway was also established, serving as the foundation for information and communications and informatization, through the broadband network construction project that connected the entire country with optical cables. These projects paved the way for Korea to be praised as a country with the fastest speed of Internet use and penetration.

Construction of national basic database in the areas of resident registration, real-estate, and vehicles and computerization of their affairs were carried out, where the focus was on computerization, or bringing offline administrative businesses online. This time, in particular, can be seen as the starting point toward the bureaucratic informatization or the age of e-Government where the government leads the social and economic growth toward overall development of the country under the aim of urging informatization despite belated industrialization.

Application of information management-centered e-government model: establishment of the early e-government for enhancing administrative productivity

A more accurate view would be that the e-Government practices in Korea had not started until the late 1990s and in 2000 when President Kim Dae-Jung administration came up with 11 e-Government initiatives.

The goal of carrying out the 11 initiatives as e-Government projects was to continue bringing offline documents to online and ensure efficiency in government administration. In order to build a government-wide integrated computing environment, e-seal and e-signature systems were developed; to provide convenience to government workers, four systems were developed as part of the project – national finance information system, educational administrative information system, standard personnel management system, and e-approval and e-document exchange system; and to bring offline government businesses to online, local government informatization schemes were developed.

During the President Roh's administration that took off in 2002, efforts to streamline and foster information management were undertaken through 31 e-Government roadmap projects involving digitalization of the entire document processing, informatization of national/local finance information, establishment of local e-Government, e-audit framework, e-national assembly, integrated criminal justice framework, comprehensive informatization of HR management administration, informatization of foreign affairs and trade, real-time management of national affairs, extended sharing of administrative information, BRM development, etc. This period, being the transformation stage from the bureaucracy-based e-Government to administrative management based e-Government, holds significance in that attempts were made to innovate the way government worked. Electronic business processes were stabilized by transforming paper documents to electronic documents, and department-based businesses to service flow-based businesses; administrative information sharing was expanded; and business processes were re-engineered for government services.

Despite such efforts, limitations can still be found in this stage: the government still provides one-way services centered around large portals where it publicize itself unilaterally; it provides supplier-oriented services using certain methods of its own choice; there are limitations on time and place; hand-written documents and online documents are used at the same time; and the government provides back-office based services that are far different from front-office based services.

Application of participatory e-government model: maturization of e-government through increased participation of citizens

E-Government practices for citizen participation can be mainly found under the President Roh's administration that took off in 2002. Also titled the 'participatory government', the administration stressed citizen participation, and saw extensive increase in the size of council organizations of private-sector members and experts throughout the entire areas of the society including the government and administration. The mainstream e-Government projects were also the ones involving citizen participation.

Under the Roh administration, 31 e-Government roadmap projects were carried out and more than 12 e-Government projects were mainly implemented for increasing online participation of citizens; improving Internet civil services; providing comprehensive services on national safety management, national welfare information, food and drug information, job information, and national logistics information; integrating and improving construction/land/registration information; and providing Internet-based service for administrative appeals, single-window G4B service, e-trade service and support service for foreigners. Citizen participation based services no longer required personal visits or face-to-face interviews but rather facilitated online services through a single window under restrictive participation. 'Civil service innovation' has emerged as a new agenda for improving services for citizens and businesses and increasing electronic participation of citizens.

One of the examples can be the project called 'e-People' service expansion, which aims to facilitate citizen engagement in policy-making process by allowing them to file complaints, give opinions and discuss policies on a single channel. The entire central and local government bodies and 14 public

institutions are connected onto the 'e-People', where complaints and suggestions are filed and processed and the results provided for review.

There are distinct functions of 'e-People', where civil service applicants only submit requests without having to check which department is in charge of the service. Anti-corruption and Civil Rights Commission then classifies requested services and distributes them to the institutions or departments in charge. More functions that 'e-People' provides are management of public suggestions and system improvement, corruption reporting, e-hearings, policy forum agenda requests and discussions, surveys, etc.

After this system was established, the average time required in processing a simple civil application was reduced by 6.7 days, from 12 in 2005 to 5.3 in 2011, whereas for processing a complex civil application, the time was reduced by 26.8 days from 36.1 to 9.3. Moreover, for better service quality, applicants can ask for additional feedback if they are not satisfied with the first one, and rate the satisfaction level again with the additional feedback.

Application of participatory e-government model: improvement toward governance-based e-government

It can be said that the governance-type e-Government in Korea has gradually emerged since the launch of the Lee Myung-Bak administration in 2008. Many researchers are forecasting that the Internet, once a passive information repository (Web 1.0), after going through user-created and user-participating system (Web 2.0), will become an intelligent companion (Web 3.0) of humans by building the capacity to understand the meaning of stored information and argue based on the knowledge. The Web 2.0 information society, based on the core values of participation, communication and sharing, has progressed to a point where citizens can actively participate in and communicate with the government. Beyond the stage of one-way service provision from the government, the government and citizens communicate with each other and even participate altogether as partners in the policy- and decision-making process.

In response to such technological and social paradigm shifts, e-Government services are also changing. One of the examples is the 'Flood Damage Community Map' service (launched on 31st of May 2012). In the past, government institutions made schemes to prevent flood damages in the rainy season, inspected poor ground facilities, required citizens to provide against potential embankment collapse, and provided campaigns. However, now with the Flood Damage Community Map, which is a new governance-type e-Government service developed by the Seoul Metropolitan Government, citizens report on potential damage spots, upon which government workers follow procedures to solve problems. In other words, it is the interactive e-Government service that is developed by both the city and citizens. This service is available on 'Agora' page of Daum, one of the largest portal service providers in Korea, for which citizens upload information and photos of road facilities exposed to potential damage, clogged or broken drains via online such as SNS. These photos are immediately delivered, together with the map service of the locations, to government workers, who can locate the sites without having to visit in person. Reports are also received through Seoul Safety Guide App and Seoul City Twitter accounts (@seoulflood, @daumagora), which came to not only minimize flood damage or take post measures but also prevent such damage.

CONCLUSION

This study defines that the social paradigm shift caused by the new IT brought the current highly-advanced information society following the industrial and information societies, and proposes a new e-Government development model that incorporates the level of social pluralism based on e-Democracy and the maturity level of civic society. The new model classifies e-Government development into four stages – bureaucratic model, information management-centered model, participatory model, and governance-type model. The study also attempted to apply this model to e-Government practices in Korea on the flow of time.

As so far explained above, e-Government in Korea has mainly shown features of one distinct model at a time among the bureaucratic, information management-centered, citizen participatory and governance-type models. However, in some stages of development, features of both bureaucratic and information management-centered models, or information management-centered and citizen participatory models were concurrently displayed. In this case, rather than the more advanced stage coming beforehand or being apparent, the former stage developed to the next level after going through the process of maturation.

Korea is expected to experience more intensified and mature governance-type e-Government services from development of the highly-advanced information society. Such highly-advanced information society is also called the 'smart society' in Korea. The word 'smart' is an adjective having the meaning of intelligent, bright, clever, efficient in speech, and thorough in transactions, etc. However, in real life, it is combined with other words such as in smart phone, smart-learning, and smart office and is used as a practical term delivering convenience and benefits. The term 'smart society' was first introduced in Korea, because the number of smart phone users in Korea reaches 28.3 million (as of end-June 2012) and a wide variety of Internet services are used via smart phones.

Korea defines the highly-advanced information society as the 'smart society' or the 'smart government'. Instead of literally interpreting the term 'smart', it should be comprehensively re-interpreted as a new academic term that reflects perspectives of social and technological changes, introducing new meanings. The definition and concept or the maturity level of the smart society shall be left for study suggestions in the future.

We have so far analyzed the characteristics of progressing toward the smart society based on Korea's cases of e-Government development. The analysis, though started from certain cases of Korea, will be an applicable model to other countries as well, for Korea is in the leading group in terms of informatization. This model, therefore, is expected to be generally expandable and applicable to e-Government cases of other countries.

REFERENCES

[1] Accenture, **e-Government Leadership: High performance, Maximum value**, 2004.

[2] C. G. Reddick, "Citizen Interaction with e-Government: From the Streets to Servers", **Government Information Quarterly**, Vol.22, 2005, pp.38–57.

[3] D. H. Cho and Y. H. Kwon, "Study on Web-based E-Government Development Model", **Thesis presented in 2002 Summer Symposium**, Korea Association for Public Administration, 2002.

[4] D. M. West, "E-Government and the Transformation of Service Delivery and Citizen Attitudes", **Public Administration Review**, Vol.64, No.1, 2004, pp.15-27.

[5] Deloitte Research, **At the dawn of e-Government: the citizen as customer**, 2003.

[6] Don Tapscott, "Implementing the Rules of Macro-wikinomics", **9th Annual Seoul Digital Forum**, 2012.

[7] Falco, Nani Beccalli et al, "IT: The Dawn of the Smart World, Connecting Innovations", **8thAnnual Seoul Digital Forum**, 2011.

[8] G. B. Kauver, "Electronic Government: Concepts, Visions, Strategies", **International Symposium on Electronic Government: Vision and Strategies**, Korean Association for Public Administration, 1998, pp. 277-286.

[9] Gartner Group, **Gartner's Four Phases of e-Government Model**, 2000.

[10] J. Palmisano Samuel, **Welcome to the Decade of Smart**, Jan. 12, 2010.

[11] Janine S. Hiller and Belanger France, **Privacy Strategies for Electronic Government, Washington**, DC: IBM Center for the Business of Government, 2001.

[12] Jeremy Rifkin, **The Third Industrial Revolution: How Lateral Power Is Transforming Energy, the Economy, and the World**, Palgrave Macmillan, 2011.

[13] K. Layne & J. Lee, "Developing fully functional E-Government: A four stage model", **Government Information Quarterly**, Vol.18, No.2, 2001, p.122

[14] K. Siau & Y. Long, "Synthesizing e-Government Stage Models - A Meta-synthesis based on Meta-ethnography approach", **Industrial Management Data Systems**, Vol. 105, No. 3/4, 2005, p.443.

[15] K.V. Andersen, & Henriksen, H.Z. "E-Government maturity models: Extension of the Layne and Lee model", **Government Information Quarterly**, Vol. 23, No. 2, 2006, pp. 236-248.

[16] Larry Keeley, "The Greatest of Innovations of All Time", **Business Week**, Feb, 2007.

[17] Moon, M. J. "The Evolution of E-Government among Municipalities: Rhetoric or Reality", **Public Administration Review**, Vol.62, No.4, 2002, p.424

[18] National Information Society Agency, "New Possibilities of the Future Society and the Role of ICT", **IT & Future Strategy Report**, Apr, 2010.

[19] National Information Society Agency, **Predicting the Paradigm Shift in the Smart Age and the ICT Strategy**, Dec, 2010.

[20] OECD, **The e-Government Imperative: Main Findings**, 2003.

[21] Peter F. Drucker, **Managing in the Next Society**, 2002.

[22] S. G. Hong, "Electronic Democracy and Politics and Government Administration in Korea", **Journal of the Korean Association of Public Policy**, 1999.

[23] S. O. Yoon, "Study on Citizen Participation in E-Government", **Korea Policy Science Journal**, Vol.7, No.1, 2003, pp.79-103.

[24] S. T. Kim, "Converging E-Democracy and E-Government Model toward Evolution model of E-Governance: The Case of the Republic of Korea", **Regional Development Dialogue**, Vol. 2, No. 2, 2006 UNCRD & UNDP, 2007.

[25] S. T. Kim, "Towards a New Paradigm of e-Government from Bureaucracy Models to Governance Model", **Building e-Governance: Challenges and Opportunities for Democracy, Administration, and Law, International Institute of Administrative Sciences in Belgium**, National Computerization Agency in Korea, 2005.

[26] S. T. Kim, **e-Government: Theory and Strategy**, Seoul: Beommunsa, 2003.

[27] S. T. Kim, **The Future Strategy of Korea for Building a Smart Society**, Seoul: Beommunsa, 2011.

[29] T. Ramsey, **On Demand Government: Continuing the e-government Journey**, IBM Press, 2004.

[30] UN, **Benchmarking e-Government: A Global Perspective**, 2002.

[31] UN, **Global e-Government Survey 2003**, 2003.

Democracy, Political Perceptions, and New Media

Dr. Houman Sadri
Department of Political Science
University of Central Florida
Orlando, FL 32816 USA

Dr. Madelyn Flammia
Department of English
University of Central Florida
Orlando, FL 32816 USA

ABSTRACT

The participation of citizens in a democratic government is often influenced by the media, particularly new communication technologies. The differences between mass media and new media are pertinent to understanding how each works to shape our opinions and perceptions. Students need to understand the role of both traditional mass media outlets and new media in shaping public participation in our society.

Keywords: democracy, new media, political perceptions, political science, social media

INTRODUCTION

Public opinion and the participation of citizens in a democratic government are closely tied to the media, particularly new communication technologies. Mass media outlets have developed numerous strategies to gain an influential power position and impressive communication ability. Students need to understand the role of both traditional mass media outlets and new media in shaping public participation in our society. One means of understanding the persuasive techniques brought to bear by mass media is through the Elaboration Likelihood Model (ELM).

THE ELABORATION LIKELIHOOD MODEL (ELM)

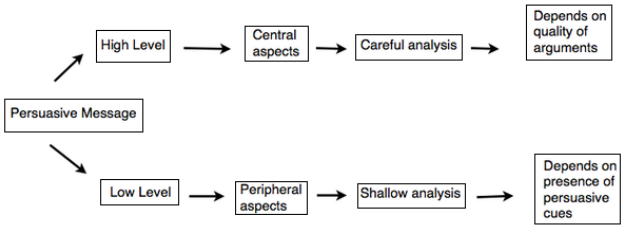
With many new and emerging technologies, the media has numerous avenues to communicate its message to the public. To understand how the media can gains its vast power, it is necessary to first understand how humans process information and the various routes to persuasion. For the purpose of this paper, persuasion is defined as the process by which one's perspectives or behaviors are influenced by receiving a message. The Elaboration Likelihood Model (ELM) was first described by Richard Petty and John Cacioppo in 1986; ELM is considered a comprehensive model of persuasion. This effective theory is used by public speakers and the professional media in order to captivate their audiences [1]. The ELM offers specific persuasion strategies that are outlined in relation to the source, message, channel, and receiver of any given communication.

As we know, humans have two memory banks, the working, or short-tem, memory where information is processed and assessed, and the long-term memory, where information is stored within nodes in the brain for future access. However, accessing nodes in the long-term memory takes time if they are not accessed regularly [2]. The process of accessing long-term memory nodes is somewhat more time-consuming than retrieving information from the short-term memory.

According to the ELM model, there are two routes to persuasion: central and peripheral. In central route processing, which takes place in the long-term memory bank, persuasion is accomplished by the quality of the argument, therefore this type of processing is based on high message elaboration. In sum, in the central route processing, the receivers or viewers are motivated to engage in effortful information processing of the message or information provided by the information source, or medium.

The other route of persuasion is through peripheral route processing. In this route of persuasion, the receivers are influenced by other factors besides the quality of the message given. For example, the receivers may be persuaded by the message or by the speaker's credentials or attractiveness [3]. With this route of persuasion, various sources of media, most notably television news networks, can capture their audience through the use of attractive anchors or state-of-the-art graphics on screen, as well as three-dimensional images and logos for the beautification of network news programs and websites. In peripheral route processing, humans take cognitive shortcuts, which respond at a top-of-the-head level to

relatively subtle cognitive cues, rather than storing gross amounts of information in the brain nodes [4].



The media uses this knowledge of cognitive processing to constructing cue words and sound bites. A viewer's attention is grabbed by displaying a message which in one word or a group of a few key words serves as an external cue. An external cue such as "9–11," can cause viewers to immediately recall information in their long-term memory more quickly as they label the nodes. By adding additional words or headlines to "9–11," the media can construct a hard-hitting message as the viewer undergoes short-term persuasion. Obviously this system of storage, along with its routes of persuasion, can serve as a problem in some events.

By creating interesting headlines by intertwining cue words such as "Osama Bin Laden" and "the Middle East," a viewer may take the peripheral route and begin to associate the two as one in the same, as the particular headline consistently appears in an attractive graphical format on-screen. Another example is the use of "Saddam Hussein" and "Iraq" in conjunction with one another. When the two cue words are constantly meshed together in a single message, many people, especially in the U.S., begin to form an association so that whenever the name Osama Bin Laden is mentioned, the brain automatically associates "terrorist" with the Middle East and the symbol of "9–11." Obviously such associations are likely to evoke negative emotions. Trending Twitter hashtags like #Muslimwatch, #Muslimterrorist and #Blamethemuslims are demonstrative of the common negative associations made by many people. This is one place where the news media has the responsibility to clearly distinguish between nations and their menaces. Overall, the menaces and events tend to serve as the necessary symbols for faster recollection of the information.

SYMBOLIC POLITICS

Students also need to understand that symbolic politics is another important aspect of how the media communicates with the public. Of course, all communication is symbolic in nature. Humans are naturally creatures of symbols which they can use to participate in interactions with other cultures. However, there are few, if any, culturally neutral symbols; it is important to note that symbols are subjective. Communication scholars Gudykunst and Kim emphasize the subjectivity of symbols when they state that "symbols are only symbols because a group of people agree to consider them as such" [5].

Therefore, the use of symbols by the media may lead to fallacies and misassumptions that in turn may spark conflicts. For example, in Europe and America, most citizens view communication as a way to interact in order to accomplish tasks. However, people in Japan, Taiwan, and China believe that information is "internalized by most members of culture." In such, high-context cultures, the shared background and knowledge of the individuals communicating with one another is a given and much of the information resides not in the explicit message but in a shared cultural context.

In every nation, the rules, values, and tradition of a culture all have a powerful impact on the communications system as a whole [6]. Therefore, political symbols often evoke and mobilize human emotions. These intense emotions historically energized some of the most devastating social, political, and religious conflicts. According to media coverage, virtually all wars that involved the U.S. have been fought around rallying symbols. The Boston Tea Party symbolized the colonials' rebellion against the British rule in favor of American liberty and self-determination [7]. Pearl Harbor symbolized the beginning of American involvement in World War Two for protection of peace and freedom, and ended the traditional policy of isolationism in favor of constructive engagement. Additionally, Japan's image was that of the military aggressor, which was made clear with their attack on Pearl Harbor, an attack that led to the United States declaring war on Tokyo. More recently, "9–11" symbolized the war against terrorism in Afghanistan. Political symbols, however, may cause serious problems if they are not presented fairly and properly.

Furthermore, visual symbols or figures play a large role in human emotions, and the same images elicit different emotions in different citizens [8]. For some individuals, images of religious figures (e.g. Buddha, Ayatollah Khomeini), or radical political leaders (e.g. Hitler, Stalin, Castro), or events (e.g. World War Two, Vietnam War) are emotional experiences. Again turning to the symbol of "9–11" and the constant footage of the attacks in New York, various types of emotions had surfaced, from sadness to anger and from fear to hate. These emotions, in combination with a lack of worldly knowledge, topped with distorted media coverage, complete a perfect a recipe for a range of problems, from local harassment of Muslims to national disputes between Washington and others. Thus, the media repeatedly displays images, which in turn transplants symbols, and eventually forms human perceptions [9]. Harrowing pictures and stories about "9-11" or in support of troops deployed in the Middle East, which villainize Muslims, are "shared" and

"retweeted" through new media even today, acting to solidify and reinforce these perceptions.

POLITICAL PERCEPTIONS

An individual's political perceptions may be shaped by mass media and by emerging digital media. Political perceptions can be defined as the process by which individuals develop impressions of the characteristics and positions of other nations and their foreign policies. These perceptions may be related to both international and domestic public opinions.

Other influences on the development of these perceptions may include cultural and social experiences, personal understanding, and the impact of institutions. These perceptions can be formed through sources of media that influence people during the crucial adolescence and adulthood periods [10]. The media's influence on perceptions is also supported by the fact that an overwhelming majority of people, for example in the United States, obtain their information about the world from television news, therefore the media unquestionably forms some impressions. In fact, the cultivation theory suggests that television cultivates a world view that is inaccurate, but that viewers often assume that the view presented reflects real life [11].

This theory can be applied when the media covers politics inaccurately or by the way in which they slant news coverage to the best interests of a particular political party. In 1989 there was a sharp increase in the number of people (68 percent of the general public in the U.S.) who believed that in reporting political news the media tended to favor one side of the story [12]. However, political perceptions influenced by various sources of media also have a major international impact in addition to a domestic one. For example, the global governance position of the U.S. has led to the international significance of American presidential campaigns in the mass media.

The global media, and increasingly new media, often influences the political perception of the international public; to understand how this influence occurs it is necessary to identify two perception factors: external stimuli and the internal perception. To identify which set of factors has more influence, it is necessary to recognize whether the perceptions originate from the image of the candidate (stimuli), or judgment of the candidate through the perceiver's own values, attitudes, and beliefs (internal perceiver). Research indicates that most voters form political perceptions and select candidates based on external stimuli [13]. However, external stimuli may also be rooted in a person's social group. New media may shape or reveal aspects of an individual's social group. Social media outlets like Twitter, Facebook, SMS text messaging, YouTube and e-mails constitute new media. Through these outlets ideas and beliefs are rapidly circulated primarily through the use of emotional appeals.

GROUP CONFLICT

Media plays a key role in determining cultural values and norms at the same time that it influences how we view other cultures internationally [14]. Each individual develops within a particular social universe, or a specific social category or group. For instance, some broad social classifications include: racial categories (e.g. "black" or "white"), ethnic or racial categories (e.g. "American" or "Japanese"), or religious categories (e.g. "Christian" or "Islamic"). The establishment of such categories is necessary for an individual to deal with the overwhelming complexity of the natural and social universes. Media plays a role in helping individuals position themselves within a social universe by associating their identity visually with a specific social universe category. The majority of such categories represent social groups, and individuals establish memberships in groups [15].

When establishing membership within a group, individuals also become aware of those individuals who are not members of their group; the terms in-group and out-group are used to define the relative positions of individuals within and outside of various societies. For the purpose of this discussion, the in-group is defined as the existing social universe, which is considered socially acceptable by the majority. The out-group consists of individuals who do not share the same beliefs and values as the in-group and is considered socially unacceptable by the majority. Due to the divergent nature of having an in-group and out-group, one assumption of in-group/out-group conflict is that all people will strive to achieve a positive social identity.

One of the means that individuals use to help manufacture a positive social identity is the process of discriminatory comparison of the in-group with some relevant out-group [16]. This discriminatory process is can be seen in media depictions of various co-cultural groups today, where misinterpretations, fallacies, and racial distortions are present. The international media is not above "in-group polarization." In fact, the media is not a neutral monitor, as it follows discursive models in which conflicts are often framed according to Western conventional wisdom [17].

The problem arises when the media products, along with their (hidden or obvious) social universe (e.g. Hollywood movies), are exported to other nations. When intercultural contact of this nature occurs, there are major implications, including cultural imperialism [18]. The process of cultural change resulting from the contact between two groups is known as acculturation, which has many implications specifically regarding ethnic identity and the social universe [19]. Hollywood productions

such as *Zero Dark Thirty*, *Generation Kill* and *Homeland* exemplify American perceptions of Muslim culture and are widely quoted and referenced in new media through use of Twitter, Facebook and online forums, particularly in casual discussions of terrorism.

Ethnic identity refers to an individual's subjective feelings belonging to a particular group. If the dominant social universe is contrary to an individual's ethnic identity, then an individual in order to maintain his self-esteem may decide to defect from the old group and join another. As noted earlier, all members wish to belong to a positive social group. If a group is viewed negatively or is not socially acceptable, then group members may wish to defect, practice social creativity, or establish social competition. The important aspect for this topic is the choice to establish a social competition against the out-group. The in-group may attempt to achieve positive distinctiveness by direct competition and confrontation with the high-status out-group. This confrontation may usually manifest itself over material assets or collective political action, such as insurgency [20]. A prime example is the Americanization or Westernization process in the Middle East.

MEDIA AND POWER

Media and power (meaning soft power) go hand in hand. We generally define power as the ability of one to change the behavior of another without the use of violence. Our definition is general enough to bridge diverse definitions of power, while it is specific enough to distinguish between power (the ability to persuade) and the use of violence (or force). Moreover, this definition considers two important points. First of all, its main focus is behavior, a general term referring to action, speech, and thoughts of an individual, a group, or a nation. Furthermore, our definition takes a neutral position by using the term "change," as opposed to "improve" or "worsen."

Knowing that the media has no military capabilities or official political authority, one may ask: what sources of power does the media occupy? Here the distinction rests on tangible and intangible conceptions of power. Western media is an example of intangible power, that is, media influence is often attributed to cultural impact (soft power), as opposed to military advancement (hard power). There are many factors involved here, but in this paper, we focus on media's power through communication, and then address some of its influential capabilities.

The news media has often been referred to as the fourth branch of government given the power of media coverage of American politics to influence political outcomes and perceptions [21]. The amount of air-time and attention given to a story affects the viewer's perception of the impact of the topic on their individual life. Post 9/11 coverage of official terror alert changes, shown below in figures 1 and 2, demonstrate the mass media's emphasis on the raising of the terror alert. This translates to an increase of concern in Americans shown in figure 3.

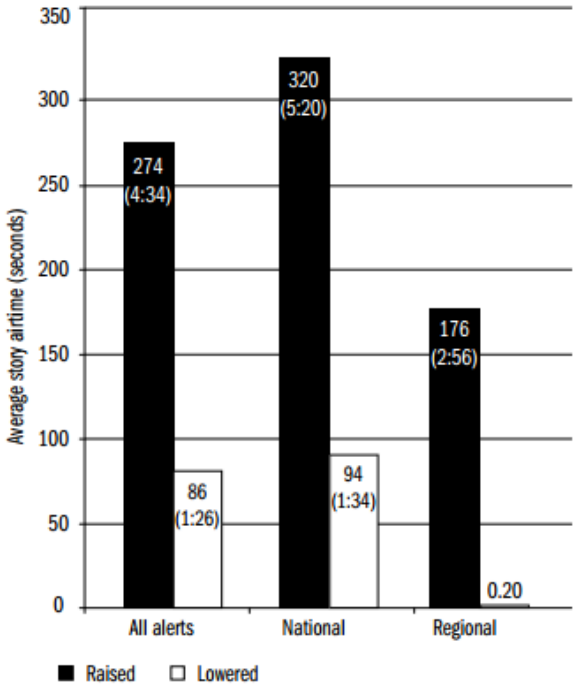


Fig. 1: TV Coverage of official terror alert changes by airtime. [22]

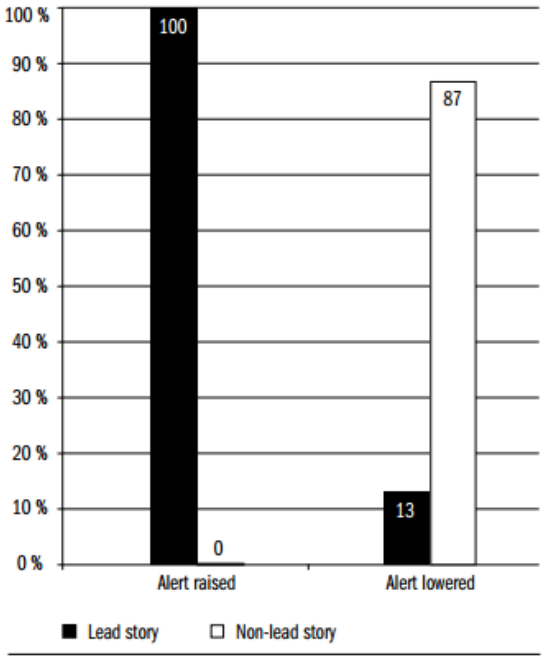


Fig. 2: TV Coverage of official terror alert changes by placement. [22]

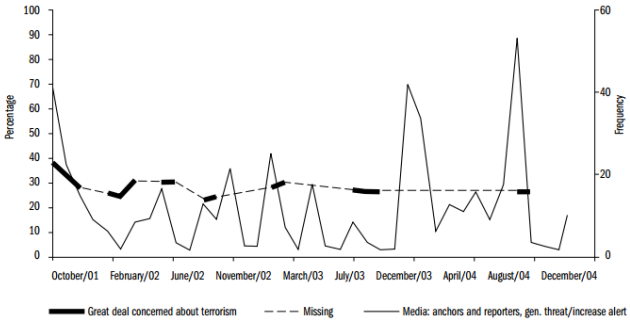


Fig. 3: Concern about major terrorist attacks [22].

CONCLUSION

The differences between mass media and new media are pertinent to understanding how each works to shape our opinions and perceptions. While mass media typically offers more credibility, new media better exemplifies the democratic spirit by allowing all individuals to participate in the discussion and reporting of information. Citizens are able to take a new and more active role in politics through interactive discussion and debate. New media also enables the reporting of real-time events, giving the individual greater access to information and the opportunity to form their own opinions and analysis before one is told to them through mass media. This allows for individuals to become critical consumers of media.

The result of new media is a diverse but accurate reflection of reality. Global trends in new media tend to support credible information and allow for the distribution and circulation of important stories and information that may have otherwise gone unreported by mass media.

Further research should examine how new media influences members of different generations and whether the consumption of and/or participation in it affects voting patterns and political perceptions. Research specifically with students may be beneficial in understanding the role of new media on changing perceptions of individual roles within politics, in addition to political perceptions in general. Research examining the influence of new media on specific minority groups versus the general population has largely been unpublished and would give additional insight and contribute to understanding changes in attitudes in individual and aggregate behavior.

REFERENCES

[1] S.R. Brydon and M.D. Scott, **Between One and Many: The Art and Science of Public Speaking**. Boston: McGraw-Hill, 2006, pp. 31 and 351.

[2] S. Iyengar and W.J. McGuire, **Explorations in Political Psychology**, London: Duke University Press, 1993.

[3] S.R. Brydon and M.D. Scott, **Between One and Many: The Art and Science of Public Speaking**. Boston: McGraw-Hill, 2006, pp. 31 and 351.

[4] S. Iyengar and W.J. McGuire, **Explorations in Political Psychology**, London: Duke University Press, 1993.

[5] W.B. Gudykunst and Y.Y. Kim, **Communicating with Strangers: An Approach to Intercultural Communication**, New York, NY: McGraw-Hill, 2003.

[6] L. A. Samovar and R.E. Porter, **Communication Between Cultures**, Australia: Wadsworth/Thompson, 2001, pp. 24–7.

[7] S. Iyengar and W.J. McGuire, **Explorations in Political Psychology**, London: Duke University Press, 1993.

[8] D.A. Graber, "Say it With Pictures," **The Annals**, Vol. 546, No. 1, 1996, pp. 85–96.

[9] M. Gilens, **Why Americans Hate Welfare**. Chicago: University of Chicago Press, 1999.

[10] S. Iyengar and W.J. McGuire, **Explorations in Political Psychology**, London: Duke University Press, 1993.

[11] R. LaRose and J. Straubhaar, **Media Now: Understanding Media, Culture, and Technology,** 5th ed., Belmont, CA: Wadsworth/Thompson, 2008, p. 405.

[12] J. Wilson and J. DiIulio. **American Government: Institutions and Policies,** 9th ed., Boston: Houghton Mifflin Company, 2004, p. 265.

[13] S. Iyengar and W.J. McGuire, **Explorations in Political Psychology**, London: Duke University Press, 1993.

[14] J.N. Pieterse, "Sociology of Humanitarian Intervention: Bosnia, Rwanda and Somalia Compared," **International Political Science Review**, Vol. 18, No. 1, 1997, pp. 77–93.

[15] S. Iyengar and W.J. McGuire, **Explorations in Political Psychology**, London: Duke University Press, 1993.

[16] S. Iyengar and W.J. McGuire, **Explorations in Political Psychology**, London: Duke University Press, 1993.

[17] J.N. Pieterse, "Sociology of Humanitarian Intervention: Bosnia, Rwanda and Somalia Compared," **International Political Science Review**, Vol. 18, No. 1, 1997, pp. 77–93

[18] J.N. Pieterse, "Sociology of Humanitarian Intervention: Bosnia, Rwanda and Somalia Compared," **International Political Science Review**, Vol. 18, No. 1, 1997, pp. 77–93

[19] R. Clement, S. Baker, G. Josephson, and K. Noels, "Media Affects on Ethnic Identity Among Linguistic Majority and Minorities A longitudinal Study of a Bilingual Setting," **Human Communication Research**, Vol. 31, No. 3, 2005.

[20]] R. Clement, S. Baker, G. Josephson, and K. Noels, "Media Affects on Ethnic Identity Among Linguistic Majority and Minorities A longitudinal Study of a Bilingual Setting," **Human Communication Research**, Vol. 31, No. 3, 2005

[21] Stephen K. Medvic. **Campaign/Elections**. First Edition. Wadsworth Publishing, 2009.

[22] B. L. Nacos and Y. Bloch-Elkon and R.Y. Shapiro. "Post 9/11 Terrorism Threats, News Coverage, and Public Perceptions in the United States." **International Journal of Conflict and Violence**, Vol. 1, No. 2, 2007, pp. 111-112

Comparative Student Success Analysis of Distance Education and Traditional Education in Associate Degree Programs

Gizem ILYAS
Dept. of Industrial Engineering, Sakarya University
Sakarya, 54052, Turkey

and

Sinan ILYAS
Adapazari Vocational High School, Sakarya University
Sakarya, 54052, Turkey

and

Hayrettin EVIRGEN
Adapazari Vocational High School, Sakarya University
Sakarya, 54052, Turkey

ABSTRACT

In this study, the success rates of students enrolled in distance education courses to students enrolled in traditional courses at Sakarya University's associate degree programs are compared. Success rates of students enrolled in distance programs and traditional programs in semester spring 2013 were analyzed with outcomes. The comparison is made for the following 3 programs; Computer Programming, Electronic Technologies and Mechatronics. Results indicated that average grades of distance students are lower than those in traditional programs.

Distance associate degree programs of Sakarya University first started in Adapazari Vocational High School in 2003. By 2013, there are 5 programs available, which are Computer Programming, Electronic Technologies, Mechatronics, Information Management and Internet and Network Technologies. Two of these programs, Information Management and Internet and Network Technologies programs aren't being lectured in traditional education, only in distance education. For that reason, the other 3 programs which are being lectured in both distance education and traditional education are analyzed.

The students' grades for each course which are common both for distance education and traditional education are analyzed. As a result of these analyzes, it is inferred that traditional education is more successful than distance education for associate degree.

Keywords: Distance Education, Traditional Education, Student Success Analysis, Benchmarking of Education Models, Associate Degree Programs.

1. INTRODUCTION

The Southern Association of Colleges and Schools defines distance education "For the purposes of the Commission on College's accreditation review, distance education is a formal educational process in which the majority of the instruction (interaction between students and instructors and among students) in a course occurs when students and instructors are not in the same place. Instruction may be synchronous or asynchronous. A distance education course may use the internet; one-way and two-way transmissions through open broadcast, closed circuit, cable, microwave, broadband lines, fiber optics, satellite, or wireless communications devices; audio conferencing; or video cassettes, DVD's, and CD-ROMs if used as part of the distance learning course or program." [1].

The Texas Higher Education Coordinating Board (THECB) defines distance education "The formal educational process that occurs when students and instructors are not in the same physical setting for the majority (more than 50 percent) of instruction." [2].

United States Distance Learning Association's distance education definition is "The application of information technology (and infrastructure) to educational and student-related activities linking teachers and students in differing places." [3].

The earliest distance learning activity was in 1728, when Caleb Phillips, a steno teacher announced in the Boston Gazette that he would like to send courses to anyone interested [4].

The applications of open and distance educations at university level started with London University founded in 1836. London University was a university which only makes exams and granting high education degrees until 1989. The students were taking courses from other institutions and attending exams at London University. The exam method of London University gave the lead to University South Africa which was founded in 1873 and University of New Zealand which was founded in 1880 [5].

The Open University which was founded in 1968 is the first open university. This university grants undergraduate degree, master's degree and doctoral degree on 91 programs. This university also has certificate programs [6].

When we have a look at the recent situation of American internet based higher education, it can be seen that internet based courses are growing up rapidly. Although 26% of the universities had internet based courses in 1999, this rate has increased up to 67% in 2008. Moreover, while the rate of internet based course was 9.6% in 2002, it is seen that this rate also increased up to 25.3% [7].

The education via letter in Ankara University Law Faculty Banking and Law of Commerce in 1950 is said to be the first instance of distance education in Turkey [8].

With the new regulations on the Law of Higher Education of Turkey in 1981, the authorization of granting distance education was given to universities, and 1 year later this mission was given to Anadolu University [9].

In 1999, Turkish Higher Education Council published the Legislation of Distance Education based on inter-universities communication and information technologies [10].

Planning facility of distance education and providing research and studying possibilities in cooperation for universities was aimed in the legislation of Turkish National Informatics Committee on March 1, 2000 [11].

According to matriculation guide of Turkey published in 2012, Computer Programming program has the largest quota among association degree distance education programs. Child Development and Business Administration programs are the second and the third ones respectively. Among undergraduate degree distance education programs, Management, Industrial Engineering and Computer Engineering have the largest quota in the order given.

Distance education activities in Sakarya University have started in 1997 via a simple interface with the course Fundamentals of Information Technologies.

Information Management and Computer Programming association degree distance education programs started in Sakarya University Sakarya Vocational High School (Sakarya VHS) in academic year 2001/02 are the first internet based distance education projects in Turkey. In academic year 2002/03, all the association degree distance education programs moved from Sakarya VHS to newly founded Adapazari Vocational High School (Adapazari VHS). Furthermore, Management associate degree program was added to these distance education programs in the same academic year.

By the academic year 2013/14, there are 6 active programs in Adapazari VHS which are Information Management, Computer Programming, Internet and Network Technologies, Electronic Technologies, Mechatronics and Occupational Health and Safety.

In this study, the students' grades for each course are analyzed and the percentages of students' success are shown in data tables. Although there is only one school teaching the analyzed programs for distance associate degree; Adapazari VHS, there are 4 different schools for traditional associate degree; Hendek VHS, Karasu VHS, Kaynarca VHS and Sakarya VHS.

The comparison is made for the following 3 programs; Computer Programming, Electronic Technologies and Mechatronics. There are 6 courses available for Computer Programming, 6 courses for Electronic Technologies and 4 courses for Mechatronics. Moreover, there are two options for traditional education; daytime and evening education. The success rates for both education types are shown in the data tables as well. The final data table shows the success rates of distance education since 2010 for both spring and fall semesters. In addition, the success rates of Information Management and Internet and Network Technologies programs which are being lectured only in distance education are provided.

2. LITERATURE REVIEW

Rivera and Rice compared the three instruction methods (traditional, web based and co-education) by means of student performance, student satisfaction and lecturer experience. In this study, students' performance was measured by examination grades and it has seen that there's no significant difference between these three instruction methods [12].

Scott has compared the successful completion and retention rates between distance education and traditional education in Californian Colleges. While the success rate of distance education was 53% in 2005/06, this rate rose to 57% in 2009/10. Likely, the success rate of traditional education rose from 64% to 67% in the same period. The gap for the success rate between traditional education and distance education decreased from 11% to 10%. Besides, the success rate for distance education grew by 2% in one year from 2008/09 to 2009/10, while the success rate for traditional courses remained the same [13].

In a study conducted by the U.S. Department of Education in 2009, it is deduced that students performed better in an online education situation than in face-to-face situations between 1996 and 2008 [14].

Harris and Parrish compared online and traditional courses and found that there was a significant difference in the learning outcomes and that the face-to-face students received significantly higher grades and had a lower dropout rate than the distance education students [15].

3. STUDENT SUCCESS ANALYSIS

In this study, 3 associate degree programs which are granted in both distance education and traditional education were compared by means of students' grades. Since Adapazari Vocational High School has only distance education programs, in order to be able to make comparison, the programs which are common in Adapazari VHS and other vocational high schools in Sakarya University which have traditional education programs were evaluated. These common programs are Computer Programming, Electronic Technologies and Mechatronics. In order to achieve the most realistic comparison, the common courses in these programs were chosen and students' grades were analyzed.

In the first place, students' grades in each common course in each vocational high school were classified according to the grading system used in Sakarya University (Table 1). As seen in this table, grades from DD to AA mean that the student is

successful. The success rate of a course is calculated by dividing the number of successful students to the number of total students taking the course. Table 2 shows the success rates for each common course in each vocational high school.

Success Rate	Grade
AA	90-100
BA	85-89
BB	80-84
CB	75-79
CC	65-74
DC	58-64
DD	50-57
FF	0-49
GR	Did not attend the final exam
DZ	Unsuccessful because of absenteeism

Table 1. Grading system used in Sakarya University

Considering the total of course grades on Table 2, cumulative success rate of each program in each vocational high school is given in Table 3. The success rates of daytime and evening educations in traditional education can be seen in this table as well. Additionally, the success rates of Internet and Network Technologies and Information Management programs which are only granted by distance education can be seen on this table.

Course 1.1	Computer Networks
Course 1.2	Graphics & Animation
Course 1.3	Internet Programming
Course 1.4	Micro Systems
Course 1.5	Total Quality Management
Course 1.6	Data Structures
Course 2.1	Alternative Current Circuit Analysis
Course 2.2	Analog Electronics
Course 2.3	Maintenance
Course 2.4	CAD
Course 2.5	Automation Systems
Course 2.6	Principles of Technology
Course 3.1	CAD
Course 3.2	Machine Elements
Course 3.3	Material Technology
Course 3.4	Mechanic Systems Design

NOS	Number of students
SR	Success rate

According to the results obtained from Table 3, distance education in Computer Programming and Electronic Technologies programs are less successful compared to traditional education. In addition, although the success rate of distance education in Mechatronics program is lower compared to evening traditional education, it is slightly higher compared to daytime traditional education. Furthermore, it can be concluded that distance education is less successful than traditional education in general.

Only the distance education programs in Adapazari VHS were taken into consideration in Table 4, and the number of students along with success rates of these programs between academic years 2010/11 and 2012/13 were shown. The change of success rates in distance education programs can be clearly seen in this table.

4. CONCLUSION

In this study, a comparison was made between distance education and traditional education based on the grades of students in vocational high schools in Sakarya University. As a result of the analysis, it is seen that distance education is less successful than traditional education. In addition, it can be seen that there's no significant change in success rates in distance education over the years. There may be many reasons causing these results. For instance, most of the students who chose distance education work in a full-time job and cannot spare time to study or even attend to the exams. Other possible reason is that these students cannot adapt their selves to a complete new system in which they have to do perfect time management and study by their own. Researching the cause of low success rates can be a subject to further studies.

Program 1	Computer Programming
Program 2	Electronic Technologies
Program 3	Mechatronics
Program 4	Information Management
Program 5	Internet and Network Technologies

DE	Distance Education
TE-1	Traditional Eduation (Daytime)
TE-2	Traditional Education (Evening)

Program	Course	School	Education Type	AA	BA	BB	CB	CC	DC	DD	DZ	FF	GR	Success Rate
Program 1	Course 1.1	Adapazari	DE	1	3	1	8	30	31	36		24	60	0,57
Program 1	Course 1.1	Hendek	TE-1	1	2		1	4	4	2		2	5	0,67
Program 1	Course 1.1	Hendek	TE-2	2		4	2	6	5	6			14	0,64
Program 1	Course 1.1	Karasu	TE-1	5		2	2	1	4	10	3	3	13	0,56
Program 1	Course 1.1	Karasu	TE-2	3	3	7	7	13	4	10		1	14	0,76
Program 1	Course 1.1	Kaynarca	TE-1					2	2	4			2	0,80
Program 1	Course 1.1	Kaynarca	TE-2					2	1	6		1		0,90
Program 1	Course 1.1	Sakarya	TE-1	2	3	2	3	11		2			8	0,74
Program 1	Course 1.2	Adapazari	DE	7	9	16	14	36	31	36		13	51	0,70
Program 1	Course 1.2	Hendek	TE-1	7	2	1	6	9	6	3			8	0,81
Program 1	Course 1.2	Hendek	TE-2	2	3	1	5	14	11	6			3	0,93
Program 1	Course 1.2	Karasu	TE-1	6	6	4	3	15	16	13		3	17	0,76
Program 1	Course 1.2	Karasu	TE-2	12	4	6	3	16	13	20		2	8	0,88
Program 1	Course 1.2	Kaynarca	TE-1	10	5	11	4	9	5	1			8	0,85
Program 1	Course 1.2	Kaynarca	TE-2	5	1	8	8	22	2	4			1	0,98
Program 1	Course 1.2	Sakarya	TE-1	2	5	4		5	6	3		6	23	0,46
Program 1	Course 1.3	Adapazari	DE			2		24	43	26		45	102	0,39
Program 1	Course 1.3	Hendek	TE-1	2	1	1		2	4	6		3	8	0,59
Program 1	Course 1.3	Hendek	TE-2	3			1	6	4	6		9	10	0,51
Program 1	Course 1.3	Karasu	TE-1	3	1	3	2	5	1	6		3	13	0,57
Program 1	Course 1.3	Karasu	TE-2	5	1	2	4	13	9	8		11	12	0,65

Program	Course	School	Education Type	AA	BA	BB	CB	CC	DC	DD	DZ	FF	GR	Success Rate
Program 1	Course 1.3	Kaynarca	TE-1	1		1			1	4		1	2	0,70
Program 1	Course 1.3	Kaynarca	TE-2			1		3	2	2		1	1	0,80
Program 1	Course 1.3	Sakarya	TE-1			3	3	8	4	6		3	13	0,60
Program 1	Course 1.4	Adapazari	DE		1	2	2	11	23	35		33	72	0,41
Program 1	Course 1.4	Hendek	TE-1	1		1	1	3	7	7	1	4	5	0,67
Program 1	Course 1.4	Hendek	TE-2	1			1	4	5	14	2	10	7	0,57
Program 1	Course 1.4	Karasu	TE-1	3	1	1	2	3	3	3	7	5	8	0,44
Program 1	Course 1.4	Karasu	TE-2	6	1	6	2	5	10	11	12	2	3	0,71
Program 1	Course 1.4	Kaynarca	TE-1				2	2		1	2	3		0,50
Program 1	Course 1.4	Kaynarca	TE-2		1	3	1	4			1			0,90
Program 1	Course 1.4	Sakarya	TE-1	2	4	5	5	3			8		4	0,61
Program 1	Course 1.5	Adapazari	DE				3	18	34	39		17	56	0,56
Program 1	Course 1.5	Hendek	TE-1	2	1	2	2	10	3	7		7	13	0,57
Program 1	Course 1.5	Hendek	TE-2	1		2		13	7	8		10	4	0,69
Program 1	Course 1.5	Karasu	TE-1	5	6	11	8	22	8	8		1	12	0,84
Program 1	Course 1.5	Karasu	TE-2	7	5	8	11	17	19	6			8	0,90
Program 1	Course 1.5	Kaynarca	TE-1		1	1	6	20	7	7		3	6	0,82
Program 1	Course 1.5	Kaynarca	TE-2	1	2	3	4	12	14	11		1	1	0,96
Program 1	Course 1.5	Sakarya	TE-1	10	5	6	7	11	1				8	0,83
Program 1	Course 1.6	Adapazari	DE	2		5	5	13	28	5		51	104	0,27
Program 1	Course 1.6	Hendek	TE-1	3	3	2	4	9	9	8		2	10	0,76
Program 1	Course 1.6	Hendek	TE-2	2	2	1	1	14	13	10		2	10	0,78
Program 1	Course 1.6	Karasu	TE-1	2	2	1	2	5	6	12	9	41	19	0,30
Program 1	Course 1.6	Karasu	TE-2		1	4	2	3	13	19	3	28	27	0,42
Program 1	Course 1.6	Kaynarca	TE-1	4	5	9	8	11	6		7		2	0,83
Program 1	Course 1.6	Kaynarca	TE-2	4	6	10	4	13	10		3			0,94
Program 1	Course 1.6	Sakarya	TE-1	3		2	1	6	3	5		9	23	0,38
Program 2	Course 2.1	Adapazari	DE				2	12	64	8		44	71	0,43
Program 2	Course 2.1	Hendek	TE-1	1			1	2	5	15		20	19	0,38
Program 2	Course 2.1	Hendek	TE-2	1				6	5	13		23	12	0,42
Program 2	Course 2.1	Sakarya	TE-1	5	1	3	2	9	8	3		15	25	0,44
Program 2	Course 2.1	Sakarya	TE-2			3	4	4	6	4		18	30	0,30
Program 2	Course 2.2	Adapazari	DE	3	1		2	15	21	6		60	96	0,24
Program 2	Course 2.2	Hendek	TE-1	1	3			3	7	8		16	16	0,41
Program 2	Course 2.2	Hendek	TE-2	3	3			4	9	14		19	10	0,53
Program 2	Course 2.2	Sakarya	TE-1	3	2	3	8	9	15	7	14	3	9	0,64
Program 2	Course 2.2	Sakarya	TE-2		4	2	5	8	15	8	21	4	17	0,50
Program 2	Course 2.3	Adapazari	DE	2	3	4	9	19	11	21		34	47	0,46
Program 2	Course 2.3	Hendek	TE-1	5	1		3	9	5	16		4	4	0,83
Program 2	Course 2.3	Hendek	TE-2	1	1		2	6	4	15		2	5	0,81
Program 2	Course 2.3	Sakarya	TE-1	4	3	2		11	9	4			8	0,80
Program 2	Course 2.3	Sakarya	TE-2	1		4	1	5	11	4			12	0,68
Program 2	Course 2.4	Adapazari	DE				4	8	14	20		16	33	0,48
Program 2	Course 2.4	Hendek	TE-1	2	2	2		5	2	9		6	26	0,41
Program 2	Course 2.4	Hendek	TE-2	1				1	2	15		18	19	0,34
Program 2	Course 2.4	Sakarya	TE-1	4	2	5	5	9	6	8	7	1	2	0,80
Program 2	Course 2.4	Sakarya	TE-2	4	1	2	7	3	5	6	10	4	13	0,51
Program 2	Course 2.5	Adapazari	DE	4	3	3	5	9	11	17		44	61	0,33
Program 2	Course 2.5	Hendek	TE-1	5	3	1	4	7	6	4		6	12	0,63
Program 2	Course 2.5	Hendek	TE-2	2	4	1	3	4	2	3		7	13	0,49
Program 2	Course 2.5	Sakarya	TE-1	1	4	5	2	6	8	7			9	0,79
Program 2	Course 2.5	Sakarya	TE-2	1	1	5	2	7	1	4		1	15	0,57
Program 2	Course 2.6	Adapazari	DE		5	2	4	32	45	21		21	83	0,51
Program 2	Course 2.6	Hendek	TE-1	2			1	17	12	34		4	17	0,76
Program 2	Course 2.6	Hendek	TE-2			4	5	22	18	16	6	9	3	0,78
Program 2	Course 2.6	Sakarya	TE-1	6	2	6	6	11	5	7		6	24	0,59
Program 2	Course 2.6	Sakarya	TE-2	3	3	3	2	4	5	11		17	38	0,36
Program 3	Course 3.1	Adapazari	DE	3	7	16	30	72	7			7	16	0,85
Program 3	Course 3.1	Sakarya	TE-1	14	6	4	6	1	2	2	29		2	0,53
Program 3	Course 3.1	Sakarya	TE-2	7	3	1	1	5	7	6		7	3	0,75
Program 3	Course 3.2	Adapazari	DE	4	4	11	11	45	30	22		49	53	0,55
Program 3	Course 3.2	Sakarya	TE-1	2	1	3	2	5	2	3	20			0,47
Program 3	Course 3.2	Sakarya	TE-2	4	1		1	3	9	10				1,00
Program 3	Course 3.3	Adapazari	DE	1		5	4	21	43	38		38	51	0,56
Program 3	Course 3.3	Sakarya	TE-1	1	8	6	8	19	3				29	0,61
Program 3	Course 3.3	Sakarya	TE-2	4	2	4	9	19	1				2	0,95
Program 3	Course 3.4	Adapazari	DE	5	1	8	4	26	23	16		52	66	0,41
Program 3	Course 3.4	Sakarya	TE-1	1	1	1	1	9	4	11	27	8	8	0,39
Program 3	Course 3.4	Sakarya	TE-2	4	1			7	5	10		8	5	0,68

Table 2. Success rates for each common course in each vocational high school.

Program	School	Education Type	AA	BA	BB	CB	CC	DC	DD	DZ	FF	GR	Success Rate
Program 1	Adapazari	DE	10	13	26	32	132	190	177	0	183	445	0,48
Program 1	Hendek	TE-1	16	9	7	14	37	33	33	1	18	49	0,69
Program 1	Hendek	TE-2	11	5	8	10	57	45	50	2	31	48	0,70
Program 1	Karasu	TE-1	24	16	22	19	51	38	52	19	56	82	0,59
Program 1	Karasu	TE-2	33	15	33	29	67	68	74	15	44	72	0,71
Program 1	Kaynarca	TE-1	15	11	22	20	44	21	17	9	7	20	0,81
Program 1	Kaynarca	TE-2	10	10	25	17	56	29	23	4	3	3	0,94
Program 1	Sakarya	TE-1	19	17	22	19	44	14	16	8	18	79	0,59
Program 4	Adapazari	DE	14	7	6	23	127	78	70	0	63	189	0,56
Program 2	Adapazari	DE	9	12	9	26	95	166	93	0	219	391	0,40
Program 2	Hendek	TE-1	16	9	3	9	43	37	86	0	56	94	0,58
Program 2	Hendek	TE-2	8	8	5	10	43	40	76	6	78	62	0,57
Program 2	Sakarya	TE-1	23	14	24	23	55	51	36	21	25	77	0,65
Program 2	Sakarya	TE-2	9	9	19	21	31	43	37	31	44	125	0,46
Program 5	Adapazari	DE	51	35	38	66	203	210	199	0	206	244	0,64
Program 3	Adapazari	DE	13	12	40	49	164	103	76	0	146	186	0,58
Program 3	Sakarya	TE-1	18	16	14	17	34	11	16	76	8	39	0,51
Program 3	Sakarya	TE-2	19	7	5	11	34	22	26	0	15	10	0,83

Table 3. Cumulative success rate of each program in each vocational high school.

		2010-2011				2011-2012				2012-2013			
		Fall		Spring		Fall		Spring		Fall		Spring	
Program	Education Type	NOS	SR	NOS	SR	NOS	SR	NOS	SR	NOS	SR	NOS	SR
InformationManagement	DE	431	0,67	396	0,66	258	0,65	200	0,55	102	0,43	382	0,56
Computer Programming	DE	918	0,74	826	0,65	654	0,57	553	0,45	512	0,57	660	0,48
Electronic Technologies	DE	633	0,69	540	0,64	496	0,49	377	0,44	385	0,40	551	0,40
Business Management	DE	422	0,67	374	0,63	247	0,64	207	0,48	125	0,46		
Mechatronics	DE	813	0,72	748	0,73	584	0,50	435	0,53	465	0,44	897	0,58
Internet & Network Technologies	DE					141	0,61	116	0,65	226	0,72	264	0,64

Table 4. The number of students and success rates of distance education programs.

5. REFERENCES

[1] Southern Association of Colleges and Schools, **Distance and Correspondence Education - Policy Statement**, 1997 (Edited: 2012), Retrieved from http://www.sacscoc.org/pdf/Distance%20and%20correspondence%20policy%20final.pdf on 12/10/2013.

[2] Texas Higher Education Coordinating Board, **Distance Education Policies, Procedures, and Forms**, Retrieved from http://www.thecb.state.tx.us/index.cfm?objectid=A5A152AC-D29D-334F-872625E9E77B3B37 on 12/10/2013.

[3] United States Distance Learning Association, **Distance Learning Glossary**, Retrieved from http://www.usdla.org/assets/pdf_files/Glossary_Distance.pdf on 12/10/2013.

[4] B. Holmberg, **Growth and Structure of Distance Education**, Routledge Kegan & Paul, 1987.

[5] G. Rumble and D. Keegan, **The Distance Teaching Universities**, Palgrave Macmillan, 1983.

[6] N. Varol, A. Varol, **Bilgi Tünelinde Eğitim Teknolojileri**, VIII Ulusal Eğitim Bilimleri Kongresi, Trabzon, Karadeniz Technical University, October 1-3, 1999.

[7] I.E. Allen, J. Seamen, **Learning On Demand: Online Education in the United States**, 2009.

[8] F. Uluğ, Z. Kaya, **Uzaktan Eğitim Yaklaşımıyla İlköğretim**, Ankara: Uzaktan Eğitim Vakfı, 1997.

[9] Z. Kaya, **Uzaktan Eğitim**, Pegema Yayıncılık, 2002.

[10] Official Journal of Turkey, **Üniversitelerarası İletişim ve Bilgi Teknolojilerine Dayalı Uzaktan Yükseköğretim Yönetmeliği**, December 14, 1999.

[11] Official Journal of Turkey, **Enformatik Milli Komitesi Yönetmeliği**, March 1, 2000.

[12] J.C.Rivera, M.L. Rice M.L, **A Comparison of Student Outcomes & Satisfaction Between Traditional & Web Based Course Offerings**, Online Journal of Distance Learning Administration, Volume V, Number III, State University of West Georgia, Distance Education Center, 2002.

[13] J. Scott, **Distance Education 2009/10 Report**, California Community Colleges Chancellor's Office, April 2011.

[14] H. Feintuch, **Keeping Their Distance**, Diverse: Issues in Higher Education, Vol 27, No 3, 2010.

[15] D. Harris, D. Parrish, **The Art of Online Teaching: Online Instruction Versus In-Class Instruction**, Journal of Technology in Human Services, Vol 24, 2006, pp. 105-117.

Distance Education Activities in Sakarya University for Associate, Undergraduate and Post-Graduate Degrees

Sinan ILYAS
Adapazari Vocational High School, Sakarya University
Sakarya, 54052, Turkey

and

Gizem ILYAS
Dept. of Industrial Engineering, Sakarya University
Sakarya, 54052, Turkey

and

Hayrettin EVIRGEN
Adapazari Vocational High School, Sakarya University
Sakarya, 54052, Turkey

ABSTRACT

In Turkey, the application of distance education was first started in Law Faculty of Ankara University in 1958. As open learning program, distance education was started by Anadolu University in 1981. By time, other universities started their own distance education programs. As a consequence of the improvement of internet infrastructure in Turkey, a new distance education type, internet based distance education gained recognition by universities. Today, Sakarya University has a distance education background for granting both certificates and university degrees. The distance education activities is being performed by Distance Education Center in Sakarya University which provides technical support for programs and supplies the infrastructure for distance education system.

Nowadays, printed materials, broadcasting and visual tools are the most common instruments used in distance education. Students can access these materials both synchronously and asynchronously through internet.

Keywords: Distance Education, Associate Degree, Undergraduate Degree, Post-Graduate Degree, Learning Management System

1. INTRODUCTION

Geber's definition of distance education is "Any formal approach to learning in which the majority of the instruction occurs while educator and learner are at a distance from each other." [1].

Moore and Kearsley defines distance education as "Planned learning normally occurring in a different place from teaching and incorporating special techniques of course design, specialized instructional techniques, and special methods of communication." [2].

According to Dabbagh and Bannan-Ritland, "online learning is an open and distributed learning enviornment that uses pedagogical tools, enabled by Internet and web-based technologies, to facilitate learning and knowledge building through meaningful action and interaction." [3].

There was an advertisement on The Boston Gazette on March 20, 1728 declaring that steno lessons would be given by letter to whoever was interested. This announcement can be considered as the start of distance education [4].

There was another advertisement about composition lessons on a Swedish newspaper in 1833. In 1840, Isaac Pitman started stenography lessons via letter in England. 3 years later, in1843, in the lead of Pitman's shool of instruction with letters, The Phonographic Correspondence Society was founded and this society organized similar distance education activities [5].

Charles Toussaint and Gustav Langenscheidt formed and organized a school for teaching foreign languages by 19 correspondences in Germany in 1856. A few years later, Anna Eliot Ticknor started a society named Society to Encourage Study at Home in the United States. The Society enrolled more than 10,000 students who are mostly women, between the years 1873 and 1897 [5].

Distance education attempts started in Germany in 1856 and later, the distance education institutions Tele Colleg, Schulfersehn, Fern Universitat, Deutsch Institut Für Fernstudien were founded. The Open University in England gave lead to The Distance University of Hagen (FernUniversität Hagen) which was founded in Germany in 1974 and started instruction in academic year 1975/76 [6].

French National Distance Education Center (Centre National D'enseigment A Distance - CNED) started instruction in 1939. This center is an official institution bound to French Ministry of National Education and organizes distant education courses on fundamental instruction, occupational instruction and formation [7].

In Turkey Initial application was performed in academic year of 1958-59 by surveying Institution of Banking and Law of Commerce, bound to the Law Faculty in Ankara University. This Institute gave banking courses to individuals who were not in Ankara by using the technique of correspondence course during two-period [8].

The fifth and seventh item in the law of high education, counted 2547, published in official journal counted in 17506 and dated on November 6th, 1981, commissioned to universities to grant distance education and then this mission was given to Anadolu University by means of law, counted 41, made in 1982 [9].

In following years it is seen that not only Anadolu University but also other universities grant distance education. After the base of Internet was formed in 1993 in Turkey, a new dimension has been brought to distance education. Initially education based on Internet began with the leader of Middle East Technical University and the application of education asynchronies based on internet was developed with the aim of expanding the departments of informatics, founded in 1997 [10].

In 1999, Presidency of Turkish Higher Education Council published the Legislation of Distance Education Based on Inter-Universities Communication and Information Technologies and aimed to create new quotas for more students who desire to study in university [11].

The first internet based distance education application was started by Middle East Technical University. Bilkent University and Istanbul University were the first to grant distance education by teleconference system. A boardcasting system was established between Istanbul University and Harran University which let the vision of electronic board in Istanbul University to be transferred to Harran University in 2000.

According to matriculation guide of Turkey published in 2012, 35 universities were granted to instruct distance associate degree programs and 11 universities were granted to instruct distance undergraduate degree programs. The quota for associate degree programs was 8,561, and for undergraduate degree, it was 3,359.

Sakarya University first started to plan granting degrees in distance education in 1997 and after years of preparations, has started internet based distance education programs in academic year 2000/01. On July 2000, Distance Education Project started in Sakarya University.

Distance education platform in Sakarya University was built with the support of IBM-Lotus and the training about the platform was achieved by the instructors of Lotus-Italy. As the first step of this project, three web based courses were served to 94 students as a pilot application. These courses were Fundamentals of Information Technologies, Computer Aided Mechanical Drawing and Logic Circuits. After this pilot application being successful, in the spring semester of academic year 2001/02, four different web based courses were served to 1200 in-campus students in 10 different programs and 10 different classes. By this way, Turkey's most comprehensive web based education was performed. At the same period, by Informatics National Comittee bounded to Turkish Higher Education Council, Sakarya University were granted to teach 2 of 4 Server University courses and achieved the status of being a Server University. Server Universities have the authorization of teaching Server University courses to other universities' students on an internet-based platform.

Before the academic year 2002/03 started, Turkish Higher Education Council decided to start the first distance associate degree programs in Turkey. After this huge step, Sakarya University started two associate programs; Information Management and Computer Programming with a quota of 500 each. A new agreement was made with IBM and the new version of IBM's distance education platform Learningspace started to be used. The distance education activities in Sakarya University are being performed as internet based asynchronious instruction [12].

In this study, the distance education activities in Sakarya University were analyzed for each associate, undergraduate and post-graduate degree programs. Although these programs use the same portal essentially, there are some differences in application. Unlike other applications, in undergraduate degree programs, there's a system named co-education which combines traditional and distance educations. Consequently, the course activities, exams, assignments, projects, virtual classes and managing the portal for each academic degree programs were analyzed.

2. LITERATURE REVIEW

Synchronious Distance Education
In this type of distance education, students and lecturers communicate via chat, real time audio and teleconference. However, in some situations, for example if there are too many students, students may have problems in teleconference system due to technological issues [13].

Asynchronious Distance Education
In asynchronious distance education, students and lectures don't have to be on the same platform at the same time. This kind of education can be either completely independent of time and platform or dependent to time and platform in certain time periods [14].

Web-Based Distance Education
Khan defines web based education as an innovative approach for delivering instruction to a remote audience, using the web as a medium [15]. According to Khan's definition, the World Wide Web functions as an instruction delivery system.

Distance Education Institutions has to deliver instruction to a various kinds of students. The properties of students that affect this variety can be their age, employment status, educational status, for how long they suspended education, etc. Therefore, the instructors need to be meticulous while determining the instruction tools and meterials. Considering that students have different properties, it can be said tht alternative instruction tools might me necessary [16].

Television Broadcasts
Open television broadcasts offers a possibility to students to study at home. This system avoids the concerns of disabled people, old people, children and retired people [17].

Mail-Based Education
In this type of education, mail groups are formed by students to study with the help of experiences and skills shared by others. Mail-Based education does not provide audio and visual resources as in web-based education, but only a text-based interaction platform.

3. DISTANCE EDUCATION ACTIVITIES IN SAKARYA UNIVERSITY

By the academic year 2012/13, 14 post graduate degree programs, 8 undergraduate degree programs and 5 associate degree programs were being instructed with distance education in Sakarya University.

In the Institue of Social Sciences, Management, Public Administiration, Local Government and Urban Development, Finance, History of Turkish Republic, Middle East Studies, Finance and Economics, Social Structure and Social Variance Analyses, International Relations and European Union, Information Management Systems and Turism Management programs, in the Institue of Natural Sciences, Information Tecnologies, Engineering Management and Quality Management programs, in the Institue of Educational Sciences, Curriculum and Instruction program are being delivered by distance education.

In Faculty of Engineering, Industrial Engineering and Computer Engineering, in Faculty of Economics and Administrative Sciences, Public Administiration, Finance, Human Resource Management, Economics, Labour Economics and Industrial Relations and International Relations programs are being delivered with Co-Education (combination of the distance and conventional educations). Besides, in Faculty of Teology, Teology undergraduate completion program, for the students who has a teology associated degree, is being delivered with distance education.

By the academic year 2013/14, there are associate degree programs in Adapazari Vocational High School which are Information Management, Computer Programming, Internet and Network Technologies, Electronic Technologies, Mechatronics and Occupational Health and Safety.

In Sakarya University, students access the distance education materials via Sakarya University Learning Management System (SAULMS). They log in the system with the same ID number and password with the Sakarya University Student Information System – SABIS. On the LMS portal, students can access the videos, lecture notes and other resources of their courses weekly and download the permitted documents as well. The course materials in the LMS portal are accessible during each semester. This system allows the students to study asynchroniously regardless of time and location.

Associate Degree Programs
Distance education associate programs in Sakarya University are collected within Adapazari Vocational High School (Adapazari VHS) in which internet-based distance education system is being used. In this system, lecturers and students communicate with each other via various electronical platforms over the internet. Students download the course materials, studies by their selves and discuss the topics with other students and/or lecturer on the discussion board.

The difference between Open Learning System and Internet-Based Distance Education is that, students have the feeling of being a regular student as in-campus students since the electronic platforms keep track of attendance to the system. In Adapazari VHS, students have the opportunity to ask questions to lecturers via the discussion board, e-mail and chat, and receive personal help.

The main course contents are on the internet-based platform as booklet e-books in downloadable format.

While the quizzes and midterm exams are carried out via internet, the final exams are carried out in-campus. Students have to be in the campus physically for final exams twice an academic year. In the two year education period, a student has to come to campus seven times in total: once for registration, four times for final exams, once for campus internship and once for receiving his/her diploma. Students register for each semester and choose courses via internet.

Undergraduate Degree Programs
Co-Education model is being used in all the undergraduate degree programs within Sakarya University. Co-Education model is a combination of traditional education techniques and synchronous and asynchronous lecture approach in conjunction with the face-to-face training in distance education by using technological tools [18].

There's no difference between Co-Education and traditional education except instruction delivery method. Students enter these programs by taking the same metriculation exam, and after registering these programs, they take the exact same courses, write their thesis and do their internship the same way in both systems. While all the lessons are delivered in in-campus in daytime and evening educations, in Co-Education, only %30 of these lessons are delivered in-campus and 70% is delivered off-campus. Co-Education students needs to come to campus on Friday and Saturday.

As in other distance education programs, videos and other materials are being uploaded to system weekly by system administrators. However, the assignments are submitted on face-to-face lessons. Additionally, midterm and final exams are carried out at the same time and in same locations with traditional education students. Likewise, quizzes are carried out in face-to-face lessons.

Some courses which are common across the university like Turkish, English and History of Turkish Republic are delivered via internet to both distance education and traditional education students.

Post-Graduate Programs
In the distance post-graduate programs within Sakarya University, students need to come to campus only for final exams for a weekend in each semester.

The lecture notes can be accessed weekly via the LMS portal during the semester as in the other distance education programs. Students and lecturers discuss the topics about each course on discussion boards.

Virtual class applications are being performed every week for an hour for each course via LMS platform. The lecturers use web-cam, microphone and headphones during these virtual

lessons. Additionally, they can share documents and chat with students. Students may also use their web-cam and microphone in case of lecturer permits. The day after the virtual class performed, system administrators pack up the virtual classes and thus, students are able to watch it again.

For each course, lecturers give two different assignments and students upload their studies in the given time period (generally in two weeks) to the platform.

Midterm exams are carried out off-campus via the distance education platform. The students may take the exam whenever they are available in a week period. However, once the exam starts, they have to complete the exam since they are not able to pause it. Additionally, final exams are carried out in-campus in a weekend stated in the academic calendar.

Under normal conditions, these programs take 3 semesters to complete. After two semesters, students have right to prepare their project with the advisor they choose. In order to graduate, each student needs not only to pass the courses, but also to be successful at his/her project and pass the proficiency exam.

4. CONCLUSION

In this study, the distance education activities in Sakarya University which is one of the leading universities in Turkey, was explained. There are differences in operation between associate, undergraduate and post-graduate programs. At this time, these activities are being performed in an internet-based model via a web portal. R&D works are ongoing in Sakarya University to support the distance education activities with new technological developments.

5. REFERENCES

[1] B. Geber, **Distance Education**, Technology and Learning, Vol 20, No 6, 2000.

[2] M.G. Moore, G. Kearsley, **Distance education: A Systems View**, Wadsworth Publishing, 2004.

[3] N. Dabbagh, B. Bannan-Ritland, **Online Learning Concepts, Strategies, and Application**, Pearson, 2005.

[4] Z. Kaya, **Uzaktan Eğitim**, Pegema Yayıncılık, 2002.

[5] M. Simonson, S. Smaldino, M. Albright, S. Zvacek, **Teaching and Learning at a Distance Foundations of Distance Education**, Upper Saddle River, 2006.

[6] N. Varol, A. Varol, **Bilgi Tünelinde Eğitim Teknolojileri**, VIII Ulusal Eğitim Bilimleri Kongresi, Trabzon, Karadeniz Technical University, October 1-3, 1999.

[7] B. Holmberg, **Theory and Practice of Distance Education**, Routledge, 1995.

[8] A. Duman, **One View of Distance Education Applications in Turkey as Regards to Adult Education**, Ankara University, Journal of Faculty of Educational Sciences, 1994, pp. 285-293.

[9] Y. Gülbahar, **E-Learning**, Pegem-Akademi Publication, 2009.

[10] B. Horzum, **Effect of Transactional Distance on Students' Achievement, Satisfaction and Self Efficacy in Internet Based Education**, Doctoral Dissertation, Department of Educational Sciences, Program of Educational Technology, 2007.

[11] R. Daş, N. Varol, **Günümüzde Uzaktan Eğitim Uygulamalarına Genel Bakış**, 1. Ulusal Bilişim–Multimedya Konferansı Bildiriler Kitabı, April 16-20, 2001.

[12] A.E. Özkul, I. Kabakçı, **İnternetle Öğretimin Yararları ve Sınırlılıkları**, Eğitim Teknolojileri Sempozyumu, Sakarya University, November 2001.

[13] A. Joliffe, J. Riter, D. Stevens, **The Online Handbook Developing and Using Web-Based Learning**, Kogan, 2001.

[14] M. İnceoğlu, **Mobil Öğretim'e Hazır mıyız?**, Açık ve Uzaktan Eğitim Sempozyumu Bildirileri, 2002.

[15] B.H. Khan, **Web-Based Instruction (WBI) What Is It and Why Is It?**, In B.H. Khan (Ed.), Web-based instruction, Englewood Cliffs, NJ Educational Technology Publications, 1997.

[16] M.E. Mutlu, M.C. Öztürk, N. Çetinöz, **Alternatif Eğitim Araçlarıyla Zenginleştirilmiş İnternete Dayalı Eğitim Modeli**, Açık ve Uzaktan Eğitim Sempozyumu Bildirileri, 2002.

[17] E.L. Oliver, **Video Tools for Distance Education**, Barry Willis (Ed.), Distance Education Strategies and Tools, Englewood Cliffs, NJ Educational Technology Publications, 1996.

[18] O. Torkul, N. Açıkgöz, M.B. Erdem, G. Çağıl, G. İlyas **An Application of Benchmarking and Root Cause Analysis of the Co-Education Model**, 10th International Conference on Education And Information Systems, Technologies And Applications/ EISTA 2012, Orlando/Florida/USA, July 17-20, 2012.

Problem-Based Learning in Teaching Information Systems - Experiences in Teaching Computational Intelligence

Rolf Dornberger
Institute for Information Systems
University of Applied Sciences Northwestern Switzerland
Peter Merian-Strasse 86
4002 Basel, Switzerland
e-mail: rolf.dornberger@fhnw.ch

and

Thomas Hanne
Institute for Information Systems
University of Applied Sciences Northwestern Switzerland
Riggenbachstr. 16
4600 Olten, Switzerland
e-mail: thomas.hanne@fhnw.ch

ABSTRACT

In this paper we discuss experiences from teaching a module in the area of Computational Intelligence within a Master study program on Business Information Systems. Preconditions and teaching concepts are discussed and contrasted with lessons learned during the previous conductions of the course.

Keywords: teaching, problem-based learning, information systems, computational intelligence, software development.

1. INTRODUCTION AND BACKGROUND

Teaching in a globalized world leads to various requirements for dealing with diverse and heterogeneous groups of students. These requirements relate to increased requests for student capabilities in academia and practice. In our Master program in Business Information Systems, students are coming from various countries around the world, e.g. from Asia, Africa, America and - for sure - from different European countries. Their education background differs as they all passed different Bachelor programs, e.g. computer science, engineering, or management in various regional education systems. In addition to their studies, the students are involved in other activities. In particular, a significant number of students work part-time in order to finance their studies or allowances.

These circumstances complicate the teaching in various ways. Notably, the education back-ground hardly allows for a clear fundament on which the Master courses can be based. For instance, skills in programming, software development, languages, and mathematics are quite diverse. If we want to provide education which includes advanced topics, preparing students for doing research on an internationally competitive standard, we need a sufficient level of such basic skills. Another requirement in modern teaching is to make the students familiar with the use of state-of-the-art tools, e.g. programming languages, software development environments (or integrated development environments), program packages for statistics, simulation, optimization, etc. all of which requires a significant amount of teaching and learning time.

In our presentation we focus on our respective experiences from a Master student course on modeling, simulation, and optimization which especially includes approaches from the field of computational intelligence. Section 2 provides a brief review of teaching styles. In Section 3 we describe the basic structure and teaching approaches of this course. In Section 4 we present our experiences from teaching. Our presentation ends with the conclusions including our lessons learned (Section 5).

2. BRIEF LITERATURE REVIEW

Teaching methods are in permanent change. During the last decades traditional teaching styles have been broadened by numerous new approaches which partly replaced old-fashioned ex-cathedra teaching [8]. Some of the arising paradigms were "learning by doing" or problem-based learning [10, 2, 6] which is based on the idea that students solve problems, possibly even real world problems, by their own creativity and without detailed teacher instructions on how the solution should be realized. Often, this approach is carried out in groups of students which additionally fosters their communication skills and may include activities from project management. Another novel paradigm is the model-centered learning [10]. The usage of new technologies provides another major change in teaching and leads to e-learning and blended learning solutions [1].

Changes in the teaching style and scenario (including, e.g., distance teaching) supports changes in our society, e.g. part-time studying and changed recreational activities and schedules. In particular, it is often assumed that changed teaching styles and scenarios may improve the student motivation and the success in study programs without lowering the transfer of knowledge and the qualifications of the graduates [2, 6]. Moreover, byproducts from the changed teaching set-up such as communication skills or capabilities in project management are highly desired by future employers.

When considering the specific situation in teaching information systems the paradigm of problem-based learning becomes even more important as a large number of activities in this field can be described as problem-solving research, sometimes also denoted as design science. Many topics, especially those related to system and software development activities can only be successfully taught when students exercise such activities [15, 16]. A successful information system teaching requires changing the students from passive learners to active participants [8].
This, in particular, holds for teaching computational intelligence topics which combine the search for sophisticated solutions with accompanying software development activities. Examples of novel teaching approaches used in this field can be found, for instance, in [7, 9, 12, 14, 17]. Our own general experiences from revising our study programs in information systems have been described in [4].

3. TEACHING CONCEPTS IN THE COURSE "MODELING, SIMULATON, AND OPTIMIZATION"

Our Master program in Business Information Systems has started in 2008. It includes around 10 courses of 4 lectures per week per semester, among them “Modeling, Simulation, and Optimization” which we treat in this presentation [13]. The course is an elective which is usually chosen in the second or fourth semester. It runs over a semester of 15 weeks having an in-class block of 4 x 45 minutes each week. These blocks are used for lectures, exercises, student presentations, and discussions. The course yields 6 ECTS points which corresponds to approximately 180 working hours of the students (including self-study time).

As “Modeling, Simulation, and Optimization” is one of the more mathematical and programming-oriented courses, the difficulties mentioned above are particularly relevant for teaching this course. In the Master program there is no other mandatory course which teaches basic skills in programming and mathematics apart from a short pre-course in programming which will give at least a short introduction in software development, algorithms and programming to those students holding a Bachelor in Business Administration or similar areas and who have no back-ground in these matters. For that reason, basic skills need to be somehow fostered during the course itself – or we must find ways how to deal with gaps in such skills. Due to time restrictions and the range of these skills, the “loophole” mentioned cannot be avoided. Only one to two of the 4 x 45 minutes blocks can be provided for general teaching on software development.

First of all, the course includes a brief tutorial in Java programming. We stick to Java as this is a widely spread open-source programming language, and later on during the course, the students have to work with an open-source Java-based software package. This package is called OpenOpal and provides basic algorithms for search and optimization and machine learning, as well as a graphical user interface and various means for analyzing and visualizing the results of the employed algorithms [3, 5]. Secondly, the students are introduced to the integrated development environment Eclipse. Thirdly, the students get an introduction into the concepts and usage of OpenOpal including its software architecture. Last but not least, a quick survey of the fundamentals of software engineering is provided in order to raise the knowledge of the complexity of larger scale programming projects.

The course itself consists mainly of regular lectures dealing with topics relating to modeling, simulation, and optimization. The optimization part is the largest and especially focusses on approaches from computational intelligence such as evolutionary algorithms, swarm intelligence, neural networks and other metaheuristics and specific approaches for multiobjective problems. The modeling situation of real-world problems onto the algorithm level, their solution respectively optimization and the transfer of the obtained results back on the real-world scale. As such teaching would only insufficiently contribute to the students’ own competences in applying respective algorithms, we request them to do their own project in this field.

The students' projects during the course are based on the idea that they get acquainted with a specific subarea in modeling, simulation, and optimization, for instance a specific optimization problem and/or a specific solution algorithm. Mostly, these specific problems or algorithms are not treated at all or only very briefly during the lectures. Then, the students are requested to implement the respective problem and/or algorithm using the OpenOpal framework. This framework allows the students to use already implemented concepts, e.g. for controlling and visualizing optimization runs. For example, they can access already implemented problems or solution algorithms for test purposes or for comparison purposes. During the course, the students deliver usually two presentations of their results presenting a scientific paper about their work and, if possible, a runnable software package. All this work is usually done in groups of 2 to 3 students. The purpose of this procedure is that the students are required to work well together already while forming the groups.

4. TEACHING EXPERIENCES

As mentioned above, the background and skills of the students are quite diverse. This can be seen in the performance achieved in these projects. For some of them, the student project does not seem to be a major challenge whereas for others it requires copious endeavors. The first part of the project, to become familiar with a new topic by self-study, is usually manageable for the student. During the lecture part of the module, the students get a general understanding, for instance of different types of optimization problems and typical strategies and algorithms for solving them. Based on this, the students can transfer their knowledge to other or more specific types of problems and to – more or less – similar solution algorithms. However, some students already struggle heavily with understanding, formulating and assessing the requirements of this optimization problem.

The programming part is more difficult, at least for some of the student groups. On the one hand, their insufficient programming skills are to blame for that. For a number of students working with a larger software framework and embedding their algorithms therein, is especially demanding (in contrast to programming smaller stand-alone algorithms on which often the teaching of programming is based). On the other hand, the programming of problems and solution algorithms requires a really substantial understanding down to the smallest detail.

Furthermore, the students are trained to work in project teams and they learn how to perform well in a group. As the students are working in groups it is not essential that every student shows a deep understanding of programming. They can distribute their project tasks according to their competences. For instance, a student with smaller programming skills can focus on the conceptual and scientific part of the project. As long as there is at least one good programmer in each group the project should be manageable.

In most cases, the project deliverables, the presentations, the paper and the software, are at least on a sufficient level (also cf. Table 1). In some cases, the software part is fragmentary (e.g. the solution considers only a special case or one example problem, or the algorithm does not use all the assumed concepts, or the software is not embedded in OpenOpal), but thanks to sufficient accomplishments in the other part the students can pass this project and the overall course (the project makes up for 50% of the final grade, the other 50% are a final exam assessing the content of the related lectures and all exercises within the projects).

Some student groups, however, do not just fulfill the basic requirements of the project but can deliver something with original content, for instance an improvement of an existing algorithm or the solution of a specific problem not well covered in the literature. In such cases the student works are suitable for conference presentations (with some additional revision) and we encourage-age the students to use such an opportunity. Another possibility is that the students continue their work in a respective Master Thesis.

Reusability of the software is an important aspect of the students work. If possible, we try to enlarge the OpenOpal software with suitable student contributions. For that purpose, the developed software does not only need to be runnable in OpenOpal and to be sufficiently generic, but also the programming style must be understandable and provide sufficient comments. This is because on the one hand, we want to provide a sufficient quality of the code in OpenOpal and, on the other hand, our resources for cleaning up the delivered code are limited.

5. CONCLUSIONS AND LESSONS LEARNED

Although the student projects conducted during the course are of heterogeneous quality, we assume that all students have substantially increased their competences in the core topics of the course and also with respect to some basic skills. The heterogeneous quality can mostly be attributed to the diverse background and skills of the students. Actually, often even students who did not pass the course with very good marks tell us that they have learned a lot.

An overview of several conductions of the course is given in Table 1. It shows that the number of students who chose that course did not drop when the module became an elective (in 2010). With respect to the marks, we observe that those for the assignments remained rather stable whereas those for the more theoretical exam part declined from 2009/10 to 2012 but could then be improved again in 2013. However, the small number of students does hardly allow for statistical significance in these numbers.

	AS 2009/10	SS 2011	SS 2012	SS 2013
no. of students in module	13	26	25	16
no. of assignments per student	3	2	2	1
avg. degree for assignments	4.87	4.92	4.9	4.69
avg. degree exam	4.62	4.22	3.77	4.65
avg. total degree	4.74	4.57	4.34	4.67

Table 1: Overview of several conductions of the course "Modeling, Simulation, and Optimization". AS = autumn semester, SS = summer semester. Grades are measured on a scale from 1 to 6, 6 being the best achievable degree. A degree of 4 is the minimum for passing a course.

The marks from the assignment(s) and the exam show only a weak positive correlation. The correlation coefficient calculated over all students and all conductions of the course is 0.181. This suggests that both parts of the module (and the respective evaluations) focus on diverse capabilities of the students.

Table 2 shows the distribution of the overall marks among the students. These marks result from the assignment marks and the exam mark. The spread of marks is rather high but similar to other courses in our study program. This reflects the diverse background, capabilities, and study efforts of the students. We could, however, manage in this course that the number of students who fail is rather small (in some conductions even zero). On the other hand, there are mostly some students with very good to excellent results (grades 5.5 to 6).

distribution of grades	AS 2009/10	SS 2011	SS 2012	SS 2013
6 (rounded)	1	0	0	2
5.5 (rounded)	3	3	0	0
5 (rounded)	3	7	5	5
4.5 (rounded)	3	8	10	4
4 (rounded)	3	4	7	5
below 4 (failed)	0	2	3	0

Table 2: Distribution of grades in the course "Modeling, Simulation, and Optimization". AS = autumn semester, SS = summer semester. Grades are measured on a scale from 1 to 6, 6 being the best achievable degree.

Over the years and during the different executions of the course we have experimented with different settings in the basic framework of the student project, e.g. with different student group sizes, by merging the groups (one group first deals with the problem, a second group with a solution technique, then they merge to combine both on the implementation level), more open or more concrete topics, or with respect to the evaluated number of presentations or papers by each group.

We found that the groups should not be too large to reduce free rider effects during the project work. A group size of three appears to be very good while groups of two students can be very effective, in particular if both students have good skills and work effectively. In exceptional cases, projects were done by a single student which often turned out to be too demanding for him or her.

The merging of groups – one working on the problem, the other working on the algorithm – turned out to be too complicated. It was often not clear how to merge the different parts and the group became large and less manageable.

With respect to the deliverables, we now only request final deliverables in the form of a (semi-) final presentation, a scientific paper, and software on which the marks are based. Additionally, the students are requested to present an intermediate presentation and to show us (the two supervising professors) the state and some preliminary results of project work, but mostly for the purpose of giving them feedback (and to make them start early with their work).

However, it remains difficult mainly due to the various skills and the background knowledge of the students which they bring with them, depending on the topics of their previous Bachelor studies (technical vs. business oriented), their working experiences - if studying part-time or having worked before joining the program, and their keenness for programming. One big opportunity has been the change in our Master of BIS, that - because of the mentioned background issues - most of the courses have become elective instead of compulsory. This concerns the course Modeling, Simulation, and Optimization as well. This has certainly ambivalent effects. On the one hand, we can hardly rely on specific previous knowledge as in the case of a less flexible study program (e.g. knowledge from other programming-oriented courses). Moreover, there is a high risk that students do not chose this course when it is perceived as too demanding or not being in accordance with their skills and prerequisites. Another disadvantage is that the profile of graduates has become less precise as there is only a small common body of knowledge to be mandatory during the study program. On the other hand, the students in class have now freely chosen this course so that we can expect them to be more interested in and motivated for this topic.

Based on these lessons learned we are going to continue the teaching of this course while still experimenting with further variations of the teaching concept. It is planned to inquire student perceptions more systematically for further improvements and a better substantiation of our findings. In particular, it would be useful to measure the actual condition of knowledge (especially with respect to general fields like software development) before and after the course. Moreover, comparisons with the experiences from other universities for similar courses would be beneficial.

9. REFERENCES

[1] D. Averberg, J. Boppert, K. Holzweißig, T. Loke, T. Riemann, and J. Magenheim, "Mobile Delivery Server (MDS) – A Solution for Resolving Problems and Limitations in Mobile E-Learning Scenarios, **The First International Conference on Mobile Communications and Learning; MCL'2006**, Mauritius; April 23-28, 2006.

[2] D. Boud and G. Feletti (eds.), **The Challenge of Problem Based Learning**, 2 ed., Routledge, 1998.

[3] R. Dornberger, R. Ernst, L. Frey, T. Hanne, "Solving Optimization Problems by Metaheuristics Using the OpenOpal Framework - Integration of Travelling Salesman Problem and Selected Solvers". **Proceedings of the VII Seminario Euro-Latinoamericano de Sistemas de Ingenieria (SELASI VII),** Valencia, Dec. 13-15, 2011

[4] R. Dornberger, T. Hanne, "E-Learning and Problem-Based Learning in Teaching Information Systems - Changing the Style of Teaching in the Information Systems Programs". **Proceedings of the 2nd International Conference on Education, Training and Informatics: ICETI 2011**, Orlando, USA, March 27 – 30, 2011

[5] R. Dornberger, T. Hanne, and L. Frey, "The Way to an Open-Source Software for Automated Optimization and Learning – OpenOpal", **Proceedings of the 2010 IEEE World Congress on Computational Intelligence (WCCI 2010)**, Barcelona, Spain, July 18-23, 2010.

[6] Z. J. Gackowski, "Case/Real-Life Problem-Based Learning with Information System Projects", **Journal of Information Technology Education**, 2003, pp. 357-365.

[7] K. J. Kim, S. B. Cho, "Game AI Competitions: An Open Platform for Computational Intelligence Education". **Computational Intelligence Magazine**, IEEE, Vol. 8, No. 3, 2013, pp. 64-68.

[8] H. Kimmel, F. P. Deek, "Teaching for understanding: Redesigning introductory courses to focus on the learner". In **Frontiers in Education Conference**, 1994. Twenty-fourth Annual Conference. Proceedings. IEEE, 1994, pp. 336-341.

[9] W. H. Land, Jr., D. Mckee, D. Reitz. "Teaching Computational Intelligence for Engineers in the 21st Century via Distance Learning", **SUNY Conference on Instructional Technology, CIT 2005**, Binghamton, NY, 23-26 May, 2005.

[10] N. Seel, **Psychologie des Lernens**, München: Ernst Reinhardt Verlag, 2000.

[11] N. M. Seel. "Model-centered learning and instruction", **Technology, Instruction, Cognition and Learning**, Vol. 1, No. 1, 2003. pp. 59-85.

[12] P. Sinčák, A. Tóth, "Using Virtual Companies in Teaching Artificial Intelligence Related Subjects", **3rd International Symposium of Hungarian Researchers on Computational Intelligence**. November 14-15, 2002, Budapest, Hungary

[13] University of Applied Sciences Northwestern Switzerland, School of Business, 2013: Homepage: http://www.fhnw.ch.

[14] G. K. K. Venayagamoorthy, "A successful interdisciplinary course on computational intelligence", **Computational Intelligence Magazine**, IEEE, Vol. 4, No. 1, 2009, pp. 14-23.

[15] G. Wilson, "Those Who Will Not Learn From History...", **Computing in Science & Engineering**, Vol. 10, No. 3, 2008, pp. 5-6.

[16] J. Woodward, H. Rieth, "A historical review of technology research in special education", **Review of Educational Research**, Vol. 67, No. 4, 1997, pp. 503-536.

[17] M. Zhang, "Experience of Teaching Computational Intelligence in an Undergraduate Level Course", **Computational Intelligence Magazine**, IEEE, Vol. 6, No. 3, 2001, pp. 57-59.

Secondary Schools Students' Language Literacy Skills Aided by the Use of Computer Tools

Dr. Odette Bourjaili Radi
Faculty of Education
La Trobe University
Victoria, 3044, Australia

Abstract

This paper presents the results of Phase 1 study investigating how and why secondary school students use computer tools (spelling and grammar checkers) to aid them in their English writing and how their patterns of use related to their literacy development. The study was centred on how some students use computers effectively to support their writing, while others struggle to read and write in English. Sixty-five Year 8 students sat the standardised literacy tests, followed by a survey. The survey covered many variables including students' perceptions on the usefulness of the spelling and grammar checkers while composing their English writing. The students' responses indicated that their regular use of computer tools (spelling and grammar checkers) at Year 8 level aided them in their English writing, but they did not retain the skills that the tools offered. Some students were unsure of their spelling so they resorted to the computer tools to aid them with their spelling and grammatical sentence structure. Their general reasons were that they did not have to remember any of the corrections due to the computer tools availability when they needed them.

Keywords: Students, computer use, spelling and grammar checkers, literacy practices, reading and writing.

1. Introduction

Since computers became part of domestic, industrial and educational environments, new and innovative technologies have created changes and challenges in all fields. Children (the Net-Generation) are more perceptive and willing to exploit the electronic devices by engaging in the digital culture to construct self-identity and community [1]. The school aged children live in the emerging world ([2], [3] and [4]), a world of transition and with a global and local focus. The use of electronic medium/ICT has influenced the way young people perceive and transform the traditional written language into a language of their own, shaped by short conventional text messaging and online-chatting ([5]). The Net-Generation have the opportunity to use the computer and their tools (spelling and grammar checkers) to present their work in a traditional form rather than in the variety that they invented. Many students trust the spelling and grammar checkers because they are very unsure of their own spelling and grammar ([6]).

2. Purpose of the study

The focus of the study has stemmed from personal observation and discussion with students over the years as a classroom teacher in the areas of Computer Studies and Humanities. With the increased use of computers in both domestic and school environments, students have displayed more interest in the use of computers, by producing typed up rather than handwritten work.

The purpose of the study is to investigate how the use of computer-based spelling and grammar checkers, may influence the students' language literacy (reading, comprehension and writing) development. In relation to language, literacy is commonly defined as the ability to read and write effectively in a range of contexts ([7]). In today's society, both language and computer literacies are of major concern to scholars and educators. The study explored the relationship between the development of students' literacy skills and their computer use in both school and domestic environments.

3. Literature review

Computers in the education and domestic environments have become a common place for both teaching and learning. The transformation of educational activities into the electronic medium has sometimes been overwhelming to the young, their families and policy makers. "What has stimulated policy change has been the beliefs about average education levels in the labour force and the claimed effect of these on economic performance" ([8]). Sternberg et al ([9]) reported that some educators are concerned about the use of features built into today's word processors, such as spelling and grammar checkers, electronic dictionaries and thesauruses. "They fear that students will become too reliant on these tools and be unable to spell, acquire sufficient vocabulary, or construct grammatically correct sentences without them". By contrast, Warschauer ([10]) concluded that the use of these tools would increase students' written language skills. He suggested that students achieve more success in their writing when they have the opportunity to use the computer tools effectively.

Several studies have investigated and evaluated the use of the spelling and grammar checkers and their implications for language literacy development for school-age children and their English writing. These tools offer different problems in that in a digital age, according to Moje ([11]), young people also have access to a local network of peers, texts and activities (e.g., massive, multiuser computer games) that are more compelling or engaging than are the texts of schools. Facilitated by the electronic medium, according to Lam ([12]), "… English language is becoming increasingly tied to the cultural expression of various groups of native and non-native around the world". The degree to which education can build on the use of computers will depend on how well we understand what students do when they work with computers ([13], [14] and [15]).

4. Research methodology

The whole study was designed in two phases:

Phase 1 of the research began with screening procedures (English literacy screening), using a quantitative methodology to collect statistical data from sixty-five Year 8 students. It

involved standardised literacy testing and a survey. Following the initial tests and survey in Phase 1, Phase 2 of the study made use of a qualitative approach to obtain more in-depth data. Six students (as case studies) were selected from the Phase 1 sample to constitute the Phase 2 informants. The students in Phase 1 were diversified achievers in their English literacy skills (reading, comprehension and writing).

The quantitative method was used to correlate the results by testing Year 8 students and collecting data to eliminate some phenomena/assumptions about the students' computer use and English writing ([16]). The number of students who consented to participate in the study was 65 (40 boys and 25 girls) out of 135 students at Year 8 level, who returned the consent forms, sat the tests and answered the questionnaire. Some of the questionnaire responses are used in this paper to complement and throw light on the literacy test results and students' perceptions of the computer tools.

The data for this paper was gathered by administering: (1) Australian Council for Educational Research (ACER) tests: Progressive Achievement Tests in Reading: Vocabulary and Comprehension (PAT – R) ([17]) and Developmental Assessment Resource for Teachers (DART – English) ([18]); and (2) a self-developed questionnaire that explored patterns of educational and domestic computer use, by Year 8 students. In light of McMillan and Schumaker's ([19]) statement, the first technique of data collection was administering the instruments at Year 8 level to obtain a broad picture of the sixty-five students' literacy skills and their patterns of ICT use.

5. English literacy screening tests

Only the reading vocabulary and comprehension parts of the ACER test booklets accompanied by Form 4 - Answer sheet, were used as they were applicable for Year 8 students. On the reading vocabulary and comprehension answer sheets, the students were not required to write anything besides mark the oval next to the correct answer. Every correct answer was worth one mark. However, the writing test required students to write two short essays in the booklet. The booklet provided them with ideas on each topic, which made it easy for students to incorporate their ideas into their writing. They were to explain their views about the 'Television' and 'The Note'. Their writings were judged on what they had to say, how well they organised their thoughts and how well they expressed themselves. The writing specimen test, tested each of two pieces of writing based on the content/context, language used and on-balance total ([18]). The results of the ACER tests, in Figure 1, set the framework for the procedures used to select the six case studies for Phase 2. Figure 1 is used to illustrate the overall average of the tests scores for both boys and girls.

5.1 Average scores of the standardised literacy tests

The results of the specimen tests were collated separately for each gender and analysed as shown in Figure 1.

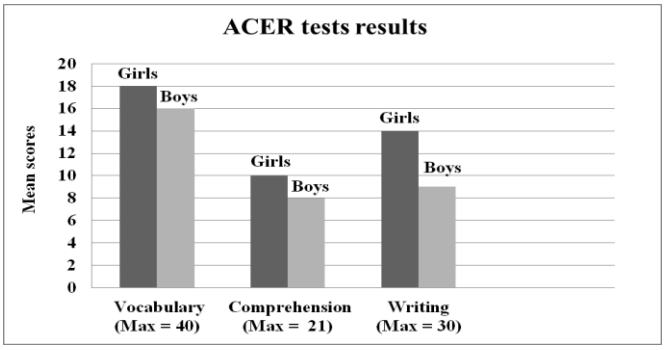


Figure 1. Girls' and boys' average performance in vocabulary, comprehension and writing tests

Figure 1 shows the overall average scores for both genders. The data reveal that the girls performed better than the boys on the standardised literacy tests. On average, the girls answered 18 questions correctly and the boys 16 questions correctly out of 40 questions in the reading vocabulary test. On the reading comprehension test, the girls' average scores were 10 correct answers and the boys' were 8 correct answers out of 21. Similarly, for the writing exercises the girls obtained an average of 14 marks and the boys obtained an average of 9 marks out of 30. These results reveal that neither gender had reached the national average standard scores on any of the literacy tests. Neither the average scores of the boys (as a group), nor those of the girls (as a group) reached the national averages of 50% on any of the three literacy tests. However, the girls achieved scores closer to the average on each test, but remained below the national average. The students who scored above the national average (from medium to high) were 48% of the girls and 29% of the boys across all measures. The remaining students had mixed scores from low to high.

6. Survey results

The survey combined questions relating to the Languages spoken at home, English literacy skills and pattern of ICT use. In addition to the standardised literacy tests, students were required to answer open-ended and closed questions in the survey to obtain more information.

6.1 Languages spoken at home

Tables 1 and 2 display details of the language(s) the students and their families spoke at home. The survey sought data to explore whether a bilingual/multilingual household influenced the students' English language development. Table 1 illustrates the diversity of the school environment as a multicultural community.

Languages	Boys %	Girls %
Only English	54	32
Bilingual/Multilingual	46	68
Total	100	100

Table 1. Language(s) the students spoke at home

Table 1 also shows that 54% of the boys and 32% of the girls reported being in families who spoke only English at home. Overall, the data suggest that more boys than girls initially acquired and practised English as the only home language. By

contrast, more girls than boys practised English and other best language(s) in their household. In some families, students were encouraged to maintain and speak both languages: English and their original language. In certain circumstances, according to the bilingual students' responses, they attended classes after school or on weekends to learn their home language.

The second question addressed which language the students most frequently spoke, read and wrote as they were growing up. Table 2 shows the students' responses.

The language most frequently used		
Languages	**Boys %**	**Girls %**
English	95	92
Other best language	5	8
Total	100	100

Table 2. The language most frequently used

Table 2 shows that 95% of boys and 92% of girls spoke, read and wrote most frequently in English, except for 5% of boys and 8% of girls whose families preferred them to practise their native tongue at home. The compulsory Languages Other Than English (LOTE) offered were and still are Japanese and Italian (from Years 7 to 10). Therefore, all students have to learn (LOTE) as an additional language.

6.2 Reading practice

Consistent with what was revealed in Tables 1 and 2, despite the diversity of languages at home, the majority of students nominated English as their preferred language in reading and writing. Barratt-Pugh and Rohl ([20]) asserted that "[l]earning in more than one language can enable children to critically analyse differences and similarities between texts. … The recognition and use of the child's home language in early childhood settings can lead to a strengthening of self-concept and confidence". The collected data sought students' ratings of their level of reading in English and their other best language. Under appropriate circumstances, reading and writing in a native language can improve and develop both vocabulary and comprehension skills in a second language ([21]), but there is little clear evidence of a consistent relationship for these students.

Students were asked to tick the appropriate box to indicate their level of reading in English and in their other best language. Table 3 shows the percentage of students according to how they rated their level of reading in each language.

Students' rating of their level of reading					
Reading in English	**Boys %**	**Girls %**	**Reading in your other best language**	**Boys %**	**Girls %**
Very good reader	53	60	Very good reader	2	4
Good Reader	40	40	Good Reader	23	52
Occasional/ Poor Reader	5		Occasional/ Poor Reader	43	32
I do not read at all	2		I do not read at all		
Left blank			Left blank	32	12
Total responses	100	100		100	100

Table 3. Students' rating of their level of reading

Table 3 records the students' self-ratings of their level of reading. The data indicates that 53% of boys and 60% of girls rated themselves as very good readers in English as well as 2% of boys and 4% of girls who rated themselves as very good readers in their other best language. Further, an equal 40% of both genders rated themselves as good readers in English with 23% of boys and 52% of girls giving themselves the same rating in their other best language. Of the boys, 5% rated themselves as occasional/poor readers in English and 43% in their other best language. The data indicate that the largest percentage of students identified themselves as proficient English readers, but overall those with other best language were markedly less confident in their reading. The data indicate that the largest percentage of students identified themselves as proficient English readers. However, the data in Figure 1 show a different result to how the students' performed in the reading vocabulary and comprehension tests. In both tests, they did not reach the national average standard.

6.3. Writing practice

Their writing test results were analysed separately for the students were required to handwrite their essays rather than marking the oval for the correct answer in reading vocabulary and comprehension tests. Figure 2 shows the results of the writing test.

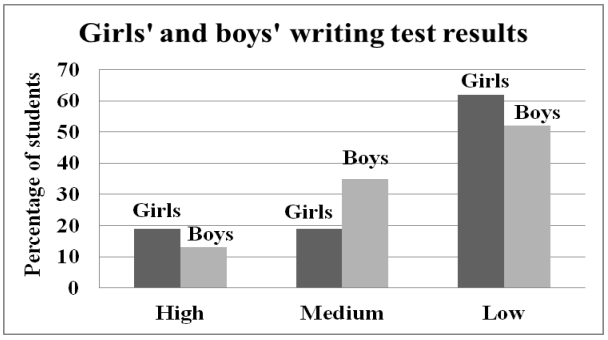


Figure 2. Girls' and boys' writing test results

The assessment criteria provided in the DART Manual were used. The scoring of each piece was recorded according to the information provided. Figure 2 shows that 62% of the girls and 52% of the boys achieved low scores for their writing pieces. Their writing, at this level, consisted of a few sentences

showing basic understanding of the demands of the task. They were brief in expressing their point of view, and lacked coherence and sequence in the plot and were lacking in context and language skills. At the medium level, 19% of the girls compared to 35% of the boys demonstrated a distinguishable story–line and attempted to incorporate the characters' names even if the characters were not well defined. They included some coherence in their writing, but there was little evidence of selection and control of the content to achieve specific purposes. At the high level, 19% of girls compared to 13% of boys achieved coherent structural arguments, justified their point of view and appropriately used detailed evidence to back up their views. Moreover, when handwriting is perceived as arduous and time-consuming, motivation to write may be greatly reduced, leading to a lack of practice that may further compound difficulties with writing ([22]).

The prominent messages stemming from several studies reveal that students should be developing an enriched vocabulary to support their comprehension of both oral and written (particularly the handwritten skills) ([23], [3] and [24]). However, for at least some of the students, controlling their writing to match standard forms of words of grammar was clearly an issue.

The results in Figure 2 reveal a substantial difference between the boys and the girls when composing their English writing pieces without the aid of the computer tools (spelling and grammar checkers). The specimen test results indicated that both boys and girls performed below the national average for their age group.

This part of the survey focused on writing. Students rated their writing from very good to poor writers. Table 4 illustrates students' responses on their writing skills in English and in their other best language.

Students' rating of their own writing					
Writing in English	Boys %	Girls %	Writing in your other best language	Boys %	Girls %
Very good	50	88	Very Good	3	8
Good	45	12	Good	30	44
Poor	5		Poor	40	36
Left blank			Left blank	27	12
Total responses	100	100		100	100

Table 4. Students' rating of their own writing

Table 4 displays the self-ratings of the students' level of writing. The data indicates that 50% of boys and 88% of girls saw themselves as very good writers in English. In contrast, among those who responded in relation to their other best language, only 3% of boys and 8% of girls rated themselves as very good. For English, 45% of boys and 12% of girls rated their writing skills as good, with 30% of boys and 44% of girls rated themselves as good writers in their other best language. However, 5% of boys (but no girls) saw themselves as poor writers in English, while 40% of boys and 36% of girls saw themselves as poor writers in their other best language. While no students left the response blank for English, some students did not answer the question for another language; 27% of boys and 12% of girls left this part of the question unanswered.

The data reveal that the students' rating of their level of writing does not match with the results in Figures 1 and 2. Overall, the writing test results, for both boys and girls, were below the national average standard. As shown in Table 4, the 50% of boys to 88% of girls who perceived themselves as very good writers were not consistent with their scores on the standardised test and suggested that the students had very different internal criteria for judging their writing from those used in standardised tests. Graham and Harris ([25]) stated that "students who experience difficulties mastering these skills may avoid writing and develop a mindset that they cannot write".

7. Computer use

I sought students' estimated time and types of their PC use to provide insight into their access to a personal computer, the frequency of computer use and estimated time spent using the computer; the main activities performed on the computer at home and at school; the frequency and types of computer use both at home and at school; the usefulness of computer tools (spelling and grammar checkers); explain the meanings of the prompts when they appear on the screen; the strategies they employed to ensure the correct word and sentence structure are selected from the spelling and grammar checkers' lists when they contain more than one suggestion.

The question about the computer activities did not provide clear instructions to the students about separating the estimated time for each activity performed on the computer. Hence, the students provided an overall estimated time for all the activities they were engaged in while using their PCs at home. The estimated time was converted to minutes for a better analysis as shown in Figure 3.

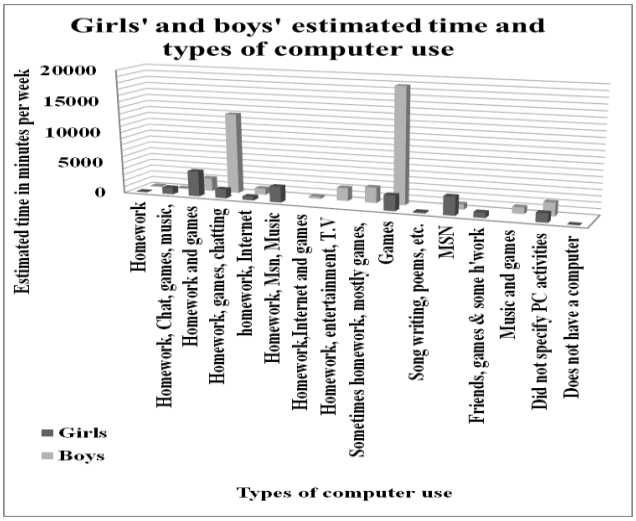


Figure 3. Girls' and boys' estimated time and types of PC use

Figure 3 demonstrates how the students spent their home time using their PCs. The girls (24 girls) reported a grand total of

17,906 minutes (298 hours = 12.41 hours per female student) spent using the computer each week. The boys (40 boys) reported a grand total of 34,130 minutes (a total of 569 hours - approximately 14.23 hours per male student) spent using the computer each week. Figure 3 shows that the girls reported a grand total of 4,105 minutes (68 hours per week) using the PC to play games and chat on MSN, but they combined these activities with some homework. They did not mention how much time they spent completing their homework. Two girls responded with 90 minutes (one and a half hour) spent on homework alone. However, the majority of the girls included homework with their other activities. The total combination of homework and other activities is 9,805 minutes (163 hours = 7 hours per female student) per week. In contrast, the data in Figure 3 shows that two boys responded with 150 minutes (2 and a half hour) spent on homework alone. The boys' total combination of activities on the computer that included homework was 11,160 minutes (186 hours – some 5 hours per male student) on average per week. The majority of the boys' responses to this part included games, internet, chatting online and some homework. Figure 3 demonstrates that there are a substantial difference between the boys' and the girls' time spent on computer activities. They used their PCs at home mainly for amusement rather than for educational purposes.

7.1 ACER test results and extent of computer use

The correlation coefficient distribution to measure the correlation between the students' responses of their estimated time (in minutes per week) spent using their personal computers against the results of the ACER tests. For writing, for both boys and girls, the overall means shows a positive relationship between minutes per week of computer use and scores on the writing test. This pattern does not hold in its entirety for vocabulary and comprehension. For vocabulary, the results for the boys and girls are quite different. The results for the girls are the same for both vocabulary (-0.01) and comprehension (-0.02). Girls who spend longer on the computer performed slightly lower on the vocabulary and comprehension tests. However, there was a much stronger negative correlation for boys (-0.19). More extensive use of computers by boys correlated negatively with vocabulary scores to such an extent that the overall correlation was also negative (-0.15). This negative result for boys indicated that the boys who spent more time on the computer showed a lower result in their vocabulary scores. As shown in Figure 3, students (boys and girls) reported spending most of their home time playing computer games, chatting online (MSN), using the internet, and much less time producing schoolwork. They used their PCs at home mainly for amusement rather than for educational purposes. There did not appear to be any difference between the boys and the girls in the activities that they reported, except that the boys spent more time playing computer games and chatting online than the girls.

8. Students' perceptions of the checkers and strategies for word and sentence replacement.

The data indicate that the majority of these students were using the electronic medium to aid them with their English writing. The data reveal that 92% of girls and 97% of boys found the spelling checker either very useful or useful. In a similar way, a total of 84% of the girls and 85% of the boys found the grammar checker either very useful or useful. The students' perceptions on the usefulness of the spelling and grammar checkers may connect with their writing test results. The actions they reported taking at the appearance of the red squiggly line in the document included: 'U click on the first one'; 'take a guess'; 'usully the one on the top'. Their use of the tools reveals that students had not integrated the information available in the tools with their mental dictionary/vocabulary to expand their literacy knowledge in English ([26])

Olsen and Williams ([27]) who have found that, while attention to what is identified by the lines (red and green underlines) improves the quality of poor writers, it makes good writers worse – since they start to rely on the spelling and grammar checkers completely, while ignoring their own instincts. They found that "… spell checkers do little to deal with issues such as the use of homonyms, such as the word 'desert' versus 'dessert'". ([27]). Grammar checkers work from a set of rules about when a plural noun is used with a singular verb in typical cases, for example, "is" versus "are" usage, but they also fail to misdiagnose many cases as well ([27]). In line with Olsen and Williams [27], Galletta et al ([28]) investigated different versions of word processors content-related features (spelling and grammar checkers). They found that the language-checking software fails to detect true errors. They reported that students should be developing an enriched vocabulary to support their comprehension of both oral and written language (particularly the handwritten skills). However, for at least some of the students, controlling their writing to match standard forms of words or grammar was clearly an issue.

9. Conclusion

The views of educators, scholars and politicians about the use of ICT and its relationships to aspects of language literacy vary. On the one hand, there are views that strongly support the use of ICT both at home and at school. These views suggest that by engaging in ICT-mediated interaction, school age children will acquire computer literacy, which may improve their learning in other areas. On the other hand, others argued that the increased use of ICT can distract school age students from learning and practising the basics of handwriting, writing and reading skills.

The results of the ACER tests, the average results in Figure 1, revealed that the students performed below the national average in the three literacy tests. The tests were based on traditional printed texts and writing skills. The evidence presented here suggests that the students rely extensively on the support from the computer tools. Two conclusions suggested by the data are: 1) lack of motivation for reading, comprehension and writing does not necessarily connect to bilingual or monolingual status; 2) high expectations of oneself and self-motivation are the motives to successfully acquire language literacy skills.

Consistent with the latter, the students' responses to the survey were that when they saw the squiggly red lines on the screen meant 'there are spelling errors. They reported that they right clicked on the spell checker list and selected a replacement word. They did the same with the squiggly green lines as it suggests an alternative to correct the sentence structure. The students' responses made it obvious that if and when they saw the prompts in the document they took steps to correct the text. Whether the students select the 'correct' word or sentence replacement they consider that an appropriate correction has been made when the coloured squiggly lines disappear from the documents. The students' correcting behaviour appeared to reflect autonomous understandings rather than more ideological

understandings of (computer) literacy that involves global social networking and the use of several digital literacies available to them.

An implication of the study for teaching is that teachers should teach the use of the spell and grammar checkers explicitly to their students so that they are equipped with the knowledge and skills to use them effectively in their writing.

References

[1] H. Mountifield, "The Information Commons: a Student-Centred Environment for IT and Information Literacy Development". In Allan Martin and Dan Madigan (Eds.). **Digital Literacies for Learning.** London Facet Publishing. 2006. Pages 172 – 181.

[2] J. Atkin. "Enhancing Learning with Information Technology: Promises, pitfalls and practicalities". **Incorporated Association of Registered Teachers of Victoria. Seminar Series** No 70. Jolimont: 1998, pp.1 – 24.

[3] F. Christie, **Language Education in the Primary Years.** Sydney: University of New South Wales Press. 2005.

[4] T Tagg, "*Wot did he say or could u not c him 4 dust?* Written and Spoken Creativity in Text Messaging". In Caroline M. L. Ho, Kate. T. Anderson and Alvin P. Leong (Eds.). **Transforming Literacies and Language: Multimodality and Literacy in the New Media Age.** London: Continuum., 2011, pp 223 – 236.

[5] F. J. Harris ,. "Challenges to Teaching Credibility Assessment in Contemporary Schooling". In Miriam J. Metzger and Andrew J. Flanagin. The John D. and Catherine T. MacArthur (Eds.). **Digital Media, Youth, and Credibility.** Cambridge, Massachusetts: The MIT Press, 2008, pp 155–180.

[6] C. Sinclair, **Grammar: A Friendly Approach.** Second Edition. Maidenhead, Bershire: Open University Press. 2010

[7] M. Forster, **Literacy and Numeracy Diagnostic Tools – An Evaluation Report,** Australian Council for Educational Research ACER), Commonwealth Department of Education, Employment and Workplace Relations (DEEWR). Canberra: 2009. http://www.deewr.gov.au/Schooling/Programs/LiteracyandNumeracy/Documents/DiagToolsReport.pdf. Retrieved 13 February, 2011,

[8] J. Lo Bianco, "Public Policy and Literacy Research Data: Will Knowing Led to Doing?" In W. Mclennan (Ed.). **Aspects of Literacy: Assessed Skill Levels.** Belconnen, ACT: Australian Bureau of Statistics.1997 pp. 80 – 88.

[9] B. J. Sternberg, K. A. Kaplan, and J. E. Borek, "Enhancing Adolescent Literacy Achievement through Integration of Technology in the Classroom". **Reading Research Quarterly.** Volume 52, No. 3, 2007, pp. 416 – 420.

[10] M. Warschauer, "Invited Commentary: New Tools for Teaching Writing". **Language Learning and Technology.** Volume 14, Number 1, 2010, pp 3 – 8.

[11] E. B. Moje, " Comprehension in the Subject Areas: The Challenges of Comprehension, Grades 7 – 12, and What to Do about Them". In Kathy Ganske and Douglas Fisher (Eds.), **Comprehension Across the Curriculum Perspectives and Practices K – 12,** New York: The Guilford Press, 2010, pp. 46 – 72.

[12] W. S. E. Lam, "L2 Literacy and the Design of the Self: A Case Study of a Teenager Writing". **TESOL Journal.** Volume 34. Issue 3. 2008, pp. 457 – 482.

[13] D. Leahy, and D. Dolan, "Digital Literacy: A Vital Competence for 2010?". In N. Reynolds and M. Turcsányi-Szabó (Eds.), **Key Competencies in the Knowledge Society**. International Federation for Information Processing (IFIP) TC 3 International Conference, KCKS 2010, Held as Part of WCC 2010, Brisbane, Australia: September 20-23, 2010. Proceedings, Volume 324, pp. 210-221.

[14] C. A. McLean, 'A Space Called Home: An Immigrant Adolescent's Digital Literacy Practices'. **Journal of Adolescent &Adult Literacy,** Volume 54. Issue1, 2010, pp 13 – 22.

[15] X. Chen, and Lee V. G, "Promoting Comprehension in Middle School and High School: Tapping into Out-of-school literacies of our Adolescents". In Kathy Ganske and Douglas Fisher (Eds.), **Comprehension Across the Curriculum Perspectives and Practices K – 12,** New York: The Guilford Press, 2010, pp. 119 – 145.

[16] M. D. Gall, J. P. Gall, and W. R. Borg, **Educational Research: An Introduction.** Seventh Edition, New York: Allyn and Bacon, 2003, pp. 319 – 321.

[17] Australian Council for Educational Research, Progressive Achievement Tests in Reading: Comprehension. Test Form 4. Third Edition. Camberwell. Australia: ACER Press, 2001.

[18] M. M. Forster, J. Mendelovits, and G. Masters, (1994). **Developmental Assessment Resource for Teachers: DART English,** Camberwell. Australia: The Australian Council for Educational Research Ltd, 1994.

[19] J. H. McMillan, and S. Schumaker, Sally. (2006). ***Research Education: Evidence-Based Inquiry.*** Sixth Edition, Boston: Pearson Education, 2006.

[20] C. Barratt-Pugh, and M Rohl, **Literacy Learning in the Early Years,** Crows Nest: Allen and Unwin. 2000, p. 178.

[21] R. Ross Johnson, "Language, Literature, Literacy and the Australian Curriculum". In G. Winch, R. Ross Johnston, P. March, L. Ljungdahl and M. Holliday (Eds.), **Literacy: Reading, Writing and Children's Literature,** Fourth Edition, South Melbourne, Victoria: Oxford University Press. pp. 459 – 487.

[22] K. Goodwin, "Is Handwriting Still an Important Skill for Kids?" http://yourkidsed.com.au/info/is-handwriting-still-an-important-skill-for-kids. 2004. Retrieved 20 December, 2010, p. 1.

[23] R. Indrisano and J S. Chall, "Literacy Development". **Journal of Education.** ,Volume 177, No 1, 1995, pp 63 – 83.

[24] J. R. Malatesha and P. G. Aaron, "Assessment of Reading Problems among English Language Learners Based on the Component Model". In Aydin Yücesan Durgunoglu (Ed.), **Language and Literacy Development in Bilingual Settings**, New York: Guilford Press 2010, pp 304 – 331.

[25] S. Graham and K. R. Harris, "Preventing Writing Difficulties: Providing Additional Handwriting and Spelling Instruction to At-Risk Children in First Grade", **Teaching Exceptional Children Journal.** Volume 38, No 5, 2006, pp. 64 – 66.

[26] J. Aitchison, **Words in the Mind: Introduction to the Mental Lexicon.** Fourth Edition, Malden. U.S.A.: Wiley and Blackwell, 2012, pp. 4 – 11.

[27] K. A. Olsen and J. G. Williams, "Spelling and Grammar Checking Using the Web as a Text repository". **Journal of the American Society for Information Science and Technology.** Volume 55, Issue 11, 2005, pp 1020 – 1023.

[28] D. F. Galletta, A.E. Durcikova, Andrea Everard, and B. M. Jones, "Does Spell-Checking Software Need a Warning Label?", **Communications of the Association for Computing Machinery Journal.** Volume 48, No. 7, 2005, pp 82 – 87.

Discovering Interdisciplinary Uses of Online Technologies in Higher Education

Mary CATON-ROSSER, PhD
Mass Communication, Black Hills State University
Spearfish, South Dakota 57799, USA

and

Barbara LOONEY, PhD
College of Business, Black Hills State University
Spearfish, South Dakota 57799, USA

and

Kaitlin SCHNEIDER
Psychology, Black Hills State University
Spearfish, South Dakota 57799, USA

ABSTRACT

Recent research shows both students and professors rushing to adapt learning and teaching activities accessing ever-upgrading digital and social media formats like Facebook, Twitter, YouTube, Pinterest and Prezi. Many institutions of higher education are embracing social media as viable, student-centered-classroom communication tools in a full range of subject disciplines, as well as in emerging interdisciplinary activities that prepare students for current trends in the job force. The new communication channels offer students a direct voice in discussion of topics of subject matter and current events, avenues for expedited exchange of information, and also introduction to skills needed to operate mobile computing devices, such as tablets and portable hand-held devices.

The advancing tools of online technology are also being used creatively in general communication across college campuses in higher education following standardized-use policies. The use of social media, for example, is effective in recruiting and interacting with prospective students and their parents or in expedited sharing of news or updated policies and procedures.

The current endorsement of new technologies in various higher-education settings aligns with historical enthusiasm in education for interactive classroom dialogue. Over the years, progressive and pragmatic educators, such as John Dewey, Paulo Freire, Elliot Eisner and Larry Cuban have promoted interactive, inclusive pedagogical communication and experiential education since the early 1900s to the present.

For the past year-and-a-half, three faculty members at Black Hills State University have been conducting qualitative and quantitative research on the use of digital and social media in higher education. Since the beginning, the central goal has been to create awareness of digital technologies and social media as inter-subjective tools. More recently, the focus has become measurement of the learning experience and the development of curricula and policies that result in improved learning and teacher-learner communication.

Keywords: social media, online technologies, interdisciplinary

INTRODUCTION

Institutions of higher education are recently encountering a new frontier and challenge of communicating effectively with their audiences. In an increasingly competitive landscape, universities and colleges are continuously strategizing to identify ways to attract students to their campuses as well as retain them until graduation -- and then maintain the relationships as alumni [1] [2]. This communication frontier -- a complex conundrum involving interdisciplinary activity -- has urged on a process of discovery regarding how to sustain regular contact with constituents. Enter the use of advancing online technologies as tools to create constant connectivity with prospective students pursuing degrees in a variety of subject matter, and then creatively continue to apply their use once the students are on campus and later graduated into their prospective fields. Rather than bemoan an era of failing interpersonal communication, colleges and universities are encouraging staff, faculty and administration to engage in positive communication and learning exchanges with prospective employees and students of diverse interests using the tools of advancing social media and digital technologies [3] [4].

GROWTH OF ONLINE TECHNOLOGIES

Web 2.0 technologies like blogs and other social media that arose on the Internet in the early part of the millennium now offer interactive and often instantaneous communication platforms for universities to recruit and register students, and relate updates about campus policies and procedures, as well as use as teaching and learning tools in classrooms. The embrace of social media such as Facebook, Twitter, LinkedIn and Pinterest, for example, is now becoming common among administrative and academic communities, although not without controversy about how, when and why to use the tools [5]. Many faculty from subject matter across the spectrum, however, find social media are viable, student-centered learning tools, no matter the discipline [6]. Much like a traditional piece of paper, social media provide channels for delivery of information on any topic. Each medium serves as a tool allowing exchange of messages – and usually much faster than the traditional piece of paper. Because the tools are also being embraced in occupations beyond the classroom, many faculty members regard their use as a logical antecedent to a range of careers in business, science, art, mathematics, military and communication, among others. Blogs have been created, for example, on all of these subjects and more [7] [8].

Additionally, because of this increased and encouraged use, many university communication departments have developed standardized-use policies regarding social media on campus and in the classroom [9] [10].

In a recent Research Bulletin released by Deloitte Consulting, Analyst S. Garr notes the growing view among companies to value a potential employee's reputation network and the entire digital footprint a new hire might bring to the workplace. [11] Fresh graduates on the employment market will increasingly need to have acquired their social media skills and connectivity while yet in college. This student need for competency and visibility through social platforms can best be achieved through sensible academic exposure and practice that focuses on effective professional use and practices.

In the classroom particularly, Web 2.0 tools are fluid pathways for students to add their direct voices in discussion of various subject matter and current events. Platforms such as Facebook and Instagram are avenues for expedited exchange of information at the flick of a finger. The use of social media is sometimes a gateway invitation to gaining the online and technical skills needed to effectively operate not only laptops, but also mobile computing devices, such as tablets and portable hand-held devices – now required on many college campuses [12].

In addition to the technical skills gained through education in the operation of devices for digital connectivity, students can grow from measured and intentional instruction that practices and refines the language of communication through these devices. Students adept at using Twitter in their social lives, for instance, are not necessarily skilled at using Twitter in their working lives.

CORE FOCUS

The writers of this paper wish to address the interdisciplinary nature of the use of online technologies that allow innovative communications within and across subject matter – and also reduce or eliminate a range of former communication and learning boundaries in higher education. The discussion and conclusion will be supported conceptually and historically via references to the work of progressive education scholars, as well as brief reviews of pedagogical examples and the results of a survey completed at Black Hills State University within the past two years.

A Collaborative Approach: Paradigm Shift That's Nothing New?

Why does interactivity – the Web 2.0 approach – seem to be suddenly revolutionizing communication in higher education? After all, offering students an interdisciplinary education – or perhaps more exactly, a multi-disciplinary education - has been a goal of progressive educators and a basic tenet of colleges and universities for years [13]. The requirement of general education credits, involving a course-mixture of science, mathematics, humanities and social sciences, for example, is a foundation of the higher education experience. An ultimate intention of gen-ed requirements for students is to create expanded awareness of the interconnected mutuality of the aforementioned subject matter, as well as encouraging specific exploration of each subject matter in and of itself [14]. Now with continuously new Web 2.0 tools, the communication among and between the subjects has become nearly fast-as-lightning and more conveniently bridged using social and digital media.

One of the foremost reasons for the paradigm shift in communications in the past ten years is advancing online technologies. Kuhn said that scientific advancement is not evolutionary, but rather a "series of peaceful interludes punctuated by intellectually violent revolutions," and in those revolutions "one conceptual world view is replaced by another" [15]. The seemingly drastic shift in one way of communicating to another -- from labor-intensive face-to-face and teletype delay to instantaneous online gratification -- has metamorphosed the former mimeo graphic processes of higher education. Progress has been driven by agents of change in administration, faculty and staff that have been scanning the horizon for radical improvements, possibilities and advancements in communication of information and knowledge – understanding when to strike when the iron is hot and morphing into a new frontier of discovery of interdisciplinary sharing that is bridging former territorial barriers, time zone concerns, and teaching methods. The collaborative process involves intergenerational, intersubjective, interspatial interactivity.

We're All in This Together, All of the Time

At times it seems that everyone on the college campus has been watching a version of "As Worlds Collide" per the philosophy of Kuhn – or potentially more appropriately termed, "As Worlds…" intersect or collaborate 24/7/365. The world of education - and the world overall - are interdisciplinary at the core, and thus as varietal needs arise and globalization takes its course, so does the need to collaborate in a multifaceted context. Real-world problem-solving is complex and involves consideration of an array of topic matter. Interdisciplinary teaching and subsequent learning and resolution of issues may involve the display of diverse perspectives, as well as the activities of joint-planning, decision-making and goal-setting. The prospects for interdisciplinary activities are growing in higher education "because of compelling, mutual gains for administration, faculty and students" [16] [17] [18]. Online technologies bring everyone together quickly, regularly, efficiently and creatively 24/7/365.

Logically, students feel as though they are more engaged or are enjoying their learning experience, they are more likely to stay at that university. From YouTube to Twitter to Skype, social media offers many benefits to both educators and students alike, such as encouraging real-time student engagement in courses to enhancing the connection between educator and student. Social media can serve as a cost-efficient tool for educators to use, as well as an effective tool to supplement and augment the delivery of course material and development of important intellectual skills [19].

Currently, researchers are interested in the opinions of students and what students desire in their classrooms. As an example of the engagement potential of social media, Cohen discovered a

significant positive link for students' perceived importance of the need to integrate Facebook into education [20]. Students have self-reported that social media in their classroom increased their engagement and helped them learn better [21] [22]. Although these reports are not yet strongly supported by empirical data, student happiness is a key aspect of retention [23].

Finally, we must not underestimate the post-graduation value to students of being capable social media navigators when they leave the classroom and apply their skills in employment settings across the disciplines.

The Study at Black Hills State University

Research on the use of online technologies in the classroom and pedagogical exchange about best practices involving a full range of subject matter has taken place at BHSU since May 2012. This section will address results of a series of monthly, one-hour roundtable discussions with ten faculty members, as well as parts of a survey conducted in spring 2013.

The agendas and materials for the roundtable discussions were prepared by two authors of this paper, and were distributed to participants by email three days before the meetings. The research surveys were distributed in paper-copy among the participating professors at the beginning of spring semester 2013. The professors administered the surveys with their students at the end of the semester.

Results / Roundtable Findings: The findings about use of online technologies and the variety of subject matter being taught included the following:

Youtube and Google Drive/Doc –English/Remedial Writing
Twitter, LinkedIn and Facebook – Outdoor Education
My Virtual Child – Adolescent Development
Youtube – Art/Crafts
Facebook – Art History and Art/Sculpture
theArtStack – Art Appreciation
Prezi – Non-profit Accounting
Youtube – Composition 101
Pinterest – Managerial Communications/Business
Blog – Humanities 100
Desire2Learn online course site – Mass Comm/Media Law
Facebook –Mass Comm/Basic and Intermediate Desktop Publishing and Design

Results / Survey Findings: Participants in the survey about digital and social media use in the classroom included three professors and 45 Black Hills State University students (24 male and 19 female). Eleven students came from a 100-level political science class, 13 students from a 400-level history class, and 22 students were from a 300-level mass communication class. The following select results highlight those questions displaying interdisciplinary activity.

Four demographic questions were asked in order to get a better idea of what populations the participant pool included. Two participants preferred not to reveal their gender, but 24 students were male (53.3%) and 19 students were female (41.3%). There were no freshman participants included in this sample, but there were 10 sophomores (22.7%), 19 juniors (43.2%), and 15 seniors (34.1%). Age groups were broken into two sections: under 25 and over 25. Thirty-one participants fell into the under 25 group (68.9%) and 14 were over 25 (31.1%). Students were asked to classify their majors. The frequency of each answer given is listed below, with the reference to the subject matter indicating the interdisciplinary commonality of the use of the online technologies.

Photography - **13**
Mass. Comm. - **12**
Pol. Sci. - **7**
Secondary Ed. Soc. Sci. - **3**
Soc. Science - **3**
History - **3**
History Ed. - **2**
Eng. Ed. - **2**
Environmental Physical Science - **1**
Psych. - **1**
Education - **1**
Theater - **1**
Electrical Engineer - **1**
Criminal Justice - **1**
Soc. - **1**
Sp. Ed. - **1**
Journalism – **1**

The results of the surveys were tallied from a Likert scale 1-10 format, and answers were rated with 1 being least and 10 being most. Question 7, out of eight total questions, asked students "which ways do you like to learn?" They were requested to rank the following digital-social media tools according to their preference for using them in class as most favorite to least favorite (#1 being the most favorable). Results are represented by an average and are listed in order of most favorite to least favorite.

Posting to Facebook - **3.51**
Google Documents - **4.82**
Creating videos for Youtube - **6.22**
Blogging - **6.44**
Using Pinterest - **6.83**
Wikis - **7.78**
Creating Prezis - **8.17**
Tweeting - **8.2**
Flickr - **8.22**
Tumblr - **8.26**

DISCUSSION

The results of both the pedagogical work and the survey show that faculty and students from a variety of subject matter are working with various online technologies and digital and social media platforms. In some instances, members of faculty based in different disciplines have begun to blog together to share best practices, engage in research projects and present their work together at conferences and via the media. The authors of this paper hail from different disciplines, but are working on an e-book that will display various lessons and the online technologies curricula of more than two dozen faculty that have been drawn into the project via a series of recent workshops on the Black Hills State University campus. Often

faculty does not readily buy into the prospect of professional development because of various factors of time commitment, varying teaching philosophies, and diverging research interests [24] [25], but it appears that a legitimate number of instructors and professors here find the interdisciplinary discovery to be interesting, worthwhile, something to embrace, and something often even collegial and "fun." The carry-over benefit to instruction, as well as the heightened interest of students, feeds the engagement once the instructors set a plan to incorporate social media.

All of the faculty members, involved in both the Roundtables and the Surveys, plan to continue utilizing social media applications for classroom adaptation. The small challenges they faced and any adjustments needed in process proved to be diminutive issues when compared to the content value and instructional energy gained by engaging Web 2.0 tools.

Because of the 24/7/365 access, interactivity and enthusiastic sharing of the plans, process and outcomes, boundaries have been dropped between disciplines, and discoveries have been made regarding the mergence of subject matter among and between students and faculty in terms of understanding and undertaking of activity and projects. The outcomes often lead to phenomenal learning experiences on the par of the posits of progressive educators. Scholars of the early to late 20th century theorized about the benefits of The Great Community [26], the deeply contextual problem-posing approach [27], identifying common purpose in education through inquiry-driven discussion and critical thinking [28], and project-based, interactive teaching and learning methods integrating subjects such as art with math and science with dance [29]. The model of interactivity at Black Hills State University regarding the integration of online technologies into various aspects of the higher education experience aligns with these posits and more.

When the study discussed in this paper, about using online technologies in the classroom, was undertaken at Black Hills State University, one of the anticipated outcomes was the development of a best practices document to share with faculty and help guide wider implementation. While such a document remains an eventual outcome, the pathway to this outcome has become wider than predicted. The potential for social media applications is broad, and with faculty from so many disciplines now involved, the gathered knowledge continually morphs and redefines itself. This plasticity makes engagement pleasurably varied. Both faculty and students continually test the perimeters and revise in process. The social media platforms themselves are regularly adapted by the media providers, based on user analysis and feedback. A the heart of any best practice guidance is acknowledged pleasure in the fluidity of the media involved and the dynamic infusion this brings to both instruction and learning.

CONCLUSION

A version of Kuhn's paradigm shift seems to be currently in process with the use of online technologies that create interdisciplinary, collaborative connections in various ways in higher education. While the shift seems recent, progressives have been advocating the activity for nearly a century in various venues of the overall educational experience, although never has there been a period of time when the tools allowing this interactive communication and pedagogy were so rapid, easily accessible and enthusiastically shared among such a broad array of demographics, psychographics and subject matter. The on-going study and experimentation at Black Hills State University since May 2012 contributes to evidence that online technologies are leading to interdisciplinary activity and discoveries.

REFERENCES

[1] Alicia Brazington, "Three Keys to Better Recruiting", **Campus Technology**, Vol. 26, No. 2, Oct 2012, pp. 26-28.

[2] Robert L. Hodum, "A Normative Code of Conduct for Admissions Officers", **New Directions for Higher Education**, No. 160, Winter 2012, pp. 29-39.

[3] John Ikenberry, Andrew Hibel, and Robert Freeman, "How Technology Has Changed (and Will Change) Higher Education Employee Recruitment", **Metropolitan Universities**, Vol. 21, No. 2, Dec 2010, pp. 44-52.

[4] Robin Lindbeck and Brian Fodrey, "Using Technology in Undergraduate Admission: A Student Perspective", **Journal of College Admission**, No. 208, Sum 2010, pp. 10-17.

[5] Michael Flavin, "Disruptive Technologies in Higher Education", **Research in Learning Technology,** Vol. 20, suppl 2012, pp. 102-111.

[6] Reneta D. Lansiquot, "Cases on Interdisciplinary Research Trends in Science, Technology, Engineering, and Mathematics: Studies on Urban Classrooms," **Advances in Educational Technologies and Instructional Design**, IGI Global, 2013.

[7] Liping Deng and Allan H. K. Yuen, "Blogs in Higher Education: Implementation and Issues," **Tech Trends: Linking Research and Practice to Improve Learning**, Vol. 53, No. 3, May 2009, pp. 95-98.

[8] Jeffrey Wee Sing Sim and Khe Foon Hew, "The Use of Weblogs in Higher Education Settings: A Review of Empirical Research," **Educational Research Review**, Vol. 5, No. 2, 2010, pp 151-163.

[9] Reynol Junco and Arthur W. Chickering, "Civil Discourse in the Age of Social Media," **About Campus**, Vol. 15, No. 4, Sept-Oct 2010, pp. 12-18.

[10] Tony McNeill, "'Don't Affect the Share Price': Social Media Policy in Higher Education as Reputation Management," **Research in Learning Technology**, Vol. 20 suppl 2012, pp. 152-162.

[11] Stacia Sherman Garr, "Why Reputations and Networks Matter in the Open Talent Economy," **Research Bulletin, Sept**. Bersin by Deloitte, Oakland, CA: Deloitte Development, 2013.

[12] Aaron Alzola Romero, "One Laptop per College Student? Exploring the Links between Access to IT Hardware and Academic Performance in Higher Education e-Learning Programs," **Journal of Distance Education**, Vol. 26, No. 1 2012.

[13] Catherine M. Wehlburg, "Integrated General Education: A Brief Look Back, **New Directions for Teaching and Learning**, No. 121, Spr 2010, pp. 3-11.

[14] Kenneth Boning, "Coherence in General Education: A Historical Look, **Journal of General Education**, Vol. 56, No. 1, 2007, pp. 1-16.

[15] Thomas Kuhn, **The Structure of Scientific Revolutions**, 1st. ed., Chicago: Univ. of Chicago Pr., 1962.

[16] A. Edwards, A., **Interdisciplinary undergraduate programs: A directory** (2nd ed.), Acton, MA: Copley, 1996.

[17] I. G. Gaff and J. L. Ratcliff, Eds, **Handbook of the undergraduate curriculum,** San Francisco: JosseyBass, 1997.

[18] J. T. Klein, **Crossing boundaries: Knowledge, disciplinarities, and interdisciplinarities**. Charlottesville and London: U of Virginia Press, 1996.

[19] Paige Abe and Nicolas A. Jordan, "Integrating Social Media into the Classroom Curriculum," **About Campus**, Wiley Periodicals, Vol. 18, No. 1, 2013, pp. 16-20.

[20] A. Cohen, "Higher education students' perspectives of the relevance of the online social networking site Facebook to education." **ProQuest Dissertations and Theses**, 2011, 137.

[21] O. S. Hirsh, "The relationship of twitter use to students' engagement and academic performance in online classes at an urban community college." **ProQuest Dissertations and Theses**, 2012, 277.

[22] R. Junco, "The relationship between frequency of Facebook use, participation in Facebook activities, and student engagement," **Computers & Education**, Vol. 58, 2012, pp. 162-171.

[23] E. L. Langevin, "Undergraduate student happiness and academic performance: A correlation study." University of Phoenix. **ProQuest Dissertations and Theses**, 2013, 109.

[24] Adrianna Kezar, "What Is the Best Way to Achieve Broader Reach of Improved Practices in Higher Education?" **Innovative Higher Education**, Vol. 36, No. 4, 2011, pp. 235-247.

[25] Stephanie L. Potter and Amanda J. Rockinson-Szapkiw, "Technology Integration for Instructional Improvement: The Impact of Professional Development," **Performance Improvement**, Vol. 51, No. 2, Feb 2012, pp. 22-27.

[26] John Dewey, **The Public and Its Problems**. Hoit Publishers, 1927.

[27] Paulo Freire, **Pedagogy of the Oppressed**. New York: Seabury, 1974.

[28] Jane L. David and Larry Cuban, **Cutting through the Hype: The Essential Guide to School Reform**. Revised, Expanded, and Updated Edition. Boston: Harvard Education Press, 2010.

[29] Elliot Eisner, **The Educational Imagination: on the design and evaluation of school programs.** MacMillan, 1994.

Women Teachers Empowered Through Trade Union Activism in England.

Jean LAIGHT
Carnegie Faculty
Leeds Metropolitan University
Leeds
United Kingdom

ABSTRACT

This paper is an exposition of doctoral work in progress which explores and examines the reasons why women teachers in England become trade union activists in the National Union of Teachers (NUT). Considering that over 75% of primary teachers in England are women, it is important to listen to what they have to say about the way they are coping with the rapid changes taking place in education in England today. With unqualified people taking over the role of the teacher, the growth of Free Schools and Academies, and the dissolution of University-educated professionals, deprofessionalisation is systematically taking place at a fast pace.

Women teachers who are active in the NUT are forthright in their desire to make changes to enhance to quality of their day to day professional lives, achieving a work-life balance and subsequently the lives of the children they teach. However, achieving a balance between their work, trade union activism and their personal lives can be difficult. This research aims to show that these women feel so passionately about their profession that they will make time and space in their already crowded lives to fight for what they believe to be a better way.

Keywords: Teachers, Women, Trade Unions, Professionalism, Activism.

INTRODUCTION

Teachers in England are being systematically set up to fail. They are being continually bombarded by changes and initiatives that are uninformed by expertise, research or common sense, but appear to be the whimsical notions of what government ministers remember as their own experiences of schools from their own childhood memories. Teachers in England are continually subjected to high level surveillance and scaremongering tactics on a daily basis. Pay scales are being dismantled and performance related pay has been re-introduced, determined by the results of high-stakes testing and government inspection. The introduction of unqualified people allowed to teach has become more wide spread, particularly in the Early Years sector, and the training of teachers is gradually being taken away from Universities and Higher Education Institutions. Qualified Teacher Status (QTS) is in danger of becoming obsolete.

Teacher education, having been elevated to a trajectory enabling teaching to become a Masters level profession, has now taken a downward turn, resulting in the downgrading of quality in the level of teacher qualifications and the inevitability of the erosion of teaching as a graduate profession. Teachers believe that they need to reclaim their professionalism and be allowed to use their highly specialised training and experience to do the job of educating the next generation of children for the benefit of everyone. Women teachers, who make up the majority of the teaching workforce, are often the teachers who are the most vulnerable, having commitments other than their careers to take into consideration in the course of their daily lives. Women teachers who are active members of the NUT provide excellent role models of

resistance and resilience as they manage to juggle their wide and varied roles and responsibilities.

REVIEW OF THE LITERATURE

Hammersley-Fletcher and Qualter [1] and Blatchford et al [2] have discussed the increasing use of and investment in support staff, and argue that teacher professionalism began to be eroded by the employment of unqualified staff to cover whole classes, thus bringing the status of the teaching profession into question. Woods and Jeffrey [3] believe that the radical changes have meant that teachers feel as though the human element of their work has been taken from them, resulting in feelings of failure and hopelessness and the continual sense of vulnerability.

Stevenson [4] cites the rapid changes that have occurred as the cause of some teachers feeling unprotected by their unions, because many teacher unions actively supported the 'Remodelling the School Workforce' [5] agenda by engaging with local and national government agencies. The NUT was the only union to abstain from signing this agreement. Stevenson's [4] research shows that, in spite of the support teachers are given by support assistants, teachers are still experiencing a heavy workload. Teachers still have the ultimate responsibility of high stakes, high pressure work and, in fact, state that they used to welcome the mundane tasks, such as photocopying, which provided a break from the intensity and enabled them to recoup their energy. The division of labour between teachers and support assistants has caused teachers to find their work highly stressful.

The language used by recent governments has also underpinned the erosion of teacher professionalism. Hayes [6] considers the further deprofessionalisation of teachers by the use of the term 'teacher training' rather than 'teacher education'. He defends the use of the word education as a broad term to describe an academic discipline, rather than the notion of skills-based training. Evans [7] concurs, arguing that governments focus largely on teachers' behaviour rather than the more cerebral qualities necessary to teaching that cannot so easily be quantified. Hayes [6] also makes the point that education is disappearing as a professional subject, making way for 'education studies'. Furthermore, Hayes focuses on the point that, under the Blair Labour government, the word 'education' was missing from the title of the government department for which it was responsible, signifying the reality of the continual erosion of teacher professionalism and autonomy over the past 20 years.

Bruton [8] argues that, in spite of the government reforms that were put in place to alleviate the heavy workload with which teachers were confronted, the National Agreement [9] did not allow for a true work-life balance for teachers to enjoy, as had been promised by the government. She states, in her thesis, that 'personal capacity and personal control are pivotal ... in order to achieve an acceptable balance', showing that management and leadership initiatives do not work in the best interests of teachers. At the same time, Payler and Locke [10] discuss the introduction of the Early Years Professional Status qualification for people working with children in the Early Years. This initiative was meant to allow the workforce reforms to move forward, but only served to consolidate the notion that teachers and their work were being undervalued, due to the perception of teachers who witnessed their work being carried out by people with lower qualifications and status than their own, believing that this intervention was lowering the standards of teaching and learning, and adding to the erosion of the teaching profession. The introduction of the recent Early Years Teacher (EYT) qualification is a step towards further professional erosion, allowing the term 'teacher' to be used when these workers will not be in possession of QTS.

THE NATIONAL UNION OF TEACHERS

The National Union of Teachers is the biggest teachers' union whose membership is made up of those who hold QTS and trainee teachers working towards QTS. This means that the strength of the Union is implicit when marshalling against the forces of teacher deprofessionalization. The NUT seeks to protect and defend teachers and their work and preserve their professional integrity. With a

history of organising and standing up for what teachers believe in, the NUT has evolved by listening to the voices of teachers since its inception and teachers are encouraged, through this democratic organisation, to be active in standing up and speaking out against what they understand to be threats to education and the substandard treatment of teachers and children alike.

Women teachers

Over 70% of the teaching workforce is made up of women. Many women teachers are greatly affected by their lack of job security, given the number of women teachers on short term or fixed term contracts. Many women teachers will also lose out on their projected pensions, not only because of the government legislation, but also because women are more likely to have had breaks in service during their careers. Further significant cuts to women's pensions can be seen where teachers take early retirement, often due to family commitments, and their pensions are actuarially reduced. Women teachers also work against the backdrop of the Comprehensive Spending Review (CSR) of 2010 [11]. According to the composite motion that was passed at the Women's Trades Union Congress (TUC) Conference 2011, women have been significantly affected by the CSR, bearing the brunt of such government intervention as the reduction in funding for services and the welfare state. Concern was particularly noted about increasing job insecurity, the impact of redundancies, the pay freezes and the substantial cuts to public services, thus causing hardship to families. The gender impact on the government's welfare reforms is causing more women than men to be forced into poverty, particularly in the public sector.

Women teachers who are responsible for their families and depend on the flexibility of supply teaching have found a significant drop in opportunities to work. The number of unqualified staff continues to rise, while supply teachers are under-utilised and have fast become privatised through the eruption of supply teacher agencies throughout England. These agencies are in business to make money, so supply teachers are paid less for their services. The terms and conditions of their work are not the same as if they were employed by a local authority and they are not afforded the protection they deserve. Women teachers who work part-time also have the insecurity of possible changes to their contracts with little control over when this might happen. Financial planning is therefore made difficult and maintaining a healthy self esteem and preserving one's identity as a valued professional under these circumstances can be difficult.

Furthermore, the role of women teachers is still often equated with motherhood and viewed through the lens of the family and hence the 'good mother' notion perpetuates [12] [13]. Teacher professionalism for men is not so clouded and therefore easier for society to recognise. Rather than taking the concept of a 'good mother' into the classroom and professionalising it, women teachers want to be acknowledged as the highly qualified, competent professionals they are. Women who are active in the NUT believe that teachers' voices need to be taken into account by government policy makers to enable the unique knowledge base that has grown through experience and reflection to contribute to the improvement of the status of teachers and the education of children. The neoliberal agenda continues to crush women teachers through attacks on both their personal and professional lives. However, these women continue to fight against the attacks on their professional status, their work-life balance and their future as qualified teachers.

METHODOLOGY

Using semi-structured interviews, 11women NUT activists were interviewed from 5 NUT Regions across England, ranging from the Northern, North West, Yorkshire/Midland, South East and London Regions. Together, these woman hold local, regional and national officer status, their ages range from 30s to 60s, 8 are currently serving teachers and 3 are retired teachers who spend a significant amount of time volunteering at their regional offices. As seen below, emerging themes can be evidenced through the following questions.

FINDINGS

'Why did you want to become a teacher?'

'I worked in the music industry. I wanted to do something that made more of a difference than that.'

(She saw a child being physically abused by a teacher and thought) 'children deserve better.'

'It was the civil service, university, teacher training college or nursing ...I applied to teacher training college and...was offered a place.'

'From a very early age...I used to teach my teddies and my dolls...I loved the idea of sharing knowledge, even though it was only small.'

'My father went into teaching...he came from a very working class background...and my father saw it as a job with wonderful opportunities and, you know, a great way of helping other people who came from similar backgrounds and I suppose, you know, you're taken by osmosis. And all my childhood he was very insistent...that girls had equal rights with boys when it came to education.'

'Why did you become an NUT activist?'

'I was brought up in a political, unionised environment.'

'My granddad was a train driver and we discussed politics. It opened my mind.'

'It's in the blood. I come from a family of socialists. It's something I would always do.'

'I became politicised (when my school was about to become an academy)'.

'I wasn't terribly unionised and I don't come from a union background...it wasn't an issue at home... Our background is, we're church goers. We're committed Christians.'

'Why do you make time and space to fight for what you believe to be a better way?'

'Being an activist has clarified my ethics and my own values'

'I feel really passionate about our profession.'

'(Teachers) need someone with empathy and understanding to speak on your behalf. Someone you trust. The Union were the voice of reason.'

'We are in an amazing profession. I look forward to getting up in the mornings.'

'I've just kept doing what I believe is the right thing to do...constantly managing the expectations.'

'Women teachers are very good at doing things...I'm doing a job, a service to others.' (NB. This is unpaid work.)

'I'm seeing teachers demoralised like never before. That's having a knock-on effect on the children because they sense that they are being taught by people who are really stressed.'

'Some people have left, or they're very miserable, demotivated or very stressed.'

'When you see something is wrong, you have to speak up. It may be that your voice gets drowned out, but if you don't try, you definitely won't get heard.'

'A lot of good will goes into education. It's a humbling profession to be in.'

Women empowered through NUT activism.

'One of the teachers said to me... You want to stay away from that lot, they're trouble, meaning the NUT lot...I got involved straight away, making placards and so on...I was involved in setting up a women's group in the school for women staff because there were so few of us there.'

'I never feel afraid to ask...I have no qualms in saying to people in the Union...I don't understand what you're talking about or that was a bit out of order or why are you saying that or why is that a barrier?'

'Being a teacher is massively important. I try and organise as much as I can and I don't get stressed when things don't happen as they should do.'

'When I'm here (on an NUT course) I no longer feel guilty because I know that they're (children) safe and I know that they're secure...so I am getting better at that.'

DISCUSSION

The emerging themes that are indicated so far in this research show that the retired women teachers had a limited choice of career, believing that a profession, such as teaching, would be a secure job and a 'job for life'. Some currently serving women teachers decided to become teachers, having worked in other spheres of employment and feeling unfulfilled in their work, believing that teaching would be more worthwhile and rewarding. Other women felt drawn to the profession from an early age. However, all the women interviewed expressed a sense of satisfaction in teaching children and did not regret becoming teachers.

Many of the women teachers interviewed joined the NUT because they had been exposed to positive influences of trade unions. Many explained how a particular critical incident had strengthened their resolve to fight for what they believed to be right, either for themselves or for colleagues who they perceived to be treated unfairly.

They are all passionate about their activism, giving their free time to help other teachers through the democratic systems of the NUT. They all believe that the teaching profession is important enough to fight for, sacrificing time and energy to help colleagues to do the work of teaching, which they believe to be an important, specialist vocation.

Being an NUT activist has empowered these women with confidence and resolve. Many cite support from other NUT activists as the driving force that enables them to continue the trade union work they do. However, many explain that the support and encouragement of their families is equally important, as the time they sacrifice often has a significant impact on those close to them.

CONCLUSION

In spite of curriculum constraints, high stakes testing and inspection, the continual and rapid changes being imposed on teachers and the gradual erosion of the professionalism of teachers and their work, these women activists are prepared to make time in their busy lives to defend and maintain their professionalism and to support and nurture the working lives of other teachers. They are passionate about the work they do, both as teachers and as trade union activists, and believe that this will ultimately have a positive impact on the pupils they teach.

REFERENCES

[1] L. Hammersley-Fletcher and A. Qualter, "Chasing improved pupil performance: the impact of policy change on school educators' perceptions of their professional identity, the case of further change in English schools", **British Educational Research Journal**, vol 36, no 6, December 2010, pp903-917.

[2] P. Blatchford, P. Bassett, P. Brown, C. Martin, A. Russell and R. Webster, "The impact of support staff on pupils' 'positive approaches to learning' and their academic progress", **British Educational Research Journal,** vol 37, no 3, June 2011, pp443-464.

[3] P. Woods and B. Jeffrey, "The reconstruction of primary teachers' identities", **British Journal of Sociology of Education,** Vol 23, No 1, 2002.

[4] H. Stevenson, "Restructuring teachers' work and trade union responses in England: Bargaining for change?" **American Educational Research Journal,** vol 11, no 2, 2007, pp 224-251

[5] Ofsted, **Remodelling the school workforce,** Ref no: HMI 2596, London, 2005.

[6] D. Hayes, **In defence of teacher education,** SCETT, London, 2011.

[7] L. Evans, "The 'shape' of teacher professionalism in England: Professional standards, performance management, professional development and the changes proposed in the 2010 White Paper", **British Educational Research Journal**, Vol 37, No 5, Oct 2011, pp 851-870.

[8] A.E. Bruton, **Work-life balance and the workforce reforms,** University of Birmingham (thesis), 2013.

[9] DfES, **Raising standards and tackling workload: a national agreement,** London, 2003

[10] J.K. Payler and R. Locke, "Disrupting communities of practice? How 'reluctant' practitioners view early years workforce reform in England", **European Early Childhood Education Research Journal**, vol 21, no 1, 2013, pp 125-137.

[11] **Comprehensive Spending Review**, UK, 2010.

[12] J. Murray, "Constructions of caring professionalism: a case study of teacher educators", **Gender and Education,** vol 18, no 4, July 2006, pp 381-397.

[13] R.W. Connell, **Gender and power,** Polity Press, Cambridge/Blackwell, Oxford, 1993.

Back to the Future of IT Resource Performance Modeling and Capacity Planning

Jayanta Choudhury
Technology Researcher, TeamQuest Corporation
Clear Lake, Iowa, 50401
jayanta.choudhury@teamquest.com,
jayanta.choudhury@gmail.com

Abstract

The glaring failure of 'healthcare.gov' is directly related to the area of performance modeling and capacity planning of computing systems. The fundamental principles of modeling of computing systems using Queueing Network Theory are based on the assumption of steady-state flow condition of the computing systems after an initial unsteady system-start state. The advent of virtualized systems with automated movements of virtual machines between physical machines and cloud computing paradigm are making computing systems so dynamic that a long enough duration of steady-state to collect data of sufficient statistical accuracy to feed to Queueing Network model of computing systems are less likely. A discrete model, based on data collected during steady-state, is not enough to predict system behavior anymore. There is a need to look at alternative scientific options to model dynamic computing systems. Dynamic computing system can be more accurately modeled as enclosure through which continuous flow of work is occurring instead of modeling a static system with a fixed average collection of work requests arriving with a fixed average inter-arrival times. Some fluid based scientific principles are identified here as suitable for modeling performance of computing systems. First order nonlinear partial differential equations for waves and boundary value problem for heat conduction is discussed by comparing with surf wave, gas flow in pipes and heat distribution in an insulated medium. There is a need to change the computer science education to include the mathematical analysis theory, related to modeling the physical phenomena of continuum, to overcome the challenges that will be posed by virtualized computing environments and cloud computing paradigm.

Keywords: Cloud Computing, Virtualized Systems, Performance Engineering, Capacity Planning, Performance Modeling

1. INTRODUCTION

The fundamentals of modeling computing systems using Queueing Network Theory (QNT) relies on Little's law and Utilization law [1]. The statement of Little's law is mathematically expressed as

$$N = \lambda W, \tag{1}$$

where λ is the arrival rate, N is concurrency and W is the response time. W is the sum of the time spent in waiting for service and the time spent receiving the service by a job request. The statement of Utilization law is expressed as

$$U = XS, \tag{2}$$

where U is utilization, X is the throughput or transactions completed per time unit and S is the average time spent receiving service by a job request. Even though Utilization law has the 'law' tag in it, it is no different than any ordinary expression used to compute utilization of any type of resource. It is a convention in the computer performance modeling to add the tag 'law' to the expression of Eq.(2). Traditionally, the S is mean or average of a random variable that follows exponential distribution and λ is mean or average of a random variable that follows Poisson distribution. The principle of QNT for computing systems assume that computing systems are network of service centers with queues associated with each service center. A simplified diagram of a QNT model for computing system is shown in Figure1. Data collected during a steady-state operation of a computing system can be used to find the statistical mean of S and λ to apply in a QNT model. Detailed study of algorithms for solving QNT models using Mean Value Analysis (MVA) can be found in [1] and [2]. Before virtualization technology, a computing system consisted of fixed capacity resources, like a CPU with fixed number of cores as well as fixed maximum execution speed of each core, a fixed amount of RAM, a fixed amount of disk storage and fixed data transfer speed through various interconnects and external networks etc. Virtual computing units have variable capacity depending on configuration and demand for running applications designed to scale on demand. This is causing many traditional pre-virtualization era modeling algorithms irrelevant.

This brings the question, how to face this challenge? Various research papers address the problem of performance measurement and modeling of virtualized system locally [3], [4]. Very little is taught about the subject of capacity and performance in traditional computer science curriculum. There are just handful of Universities that include a faculty in that area. Jeff Buzen of Hravard Untiversity (retired), Mani Chandy of University of Texas at Austin, Raj Jain of Washington University in St. Louis, Daniel Menasce of George Mason University are a few very popular names. The result of ignorance is the glaring failure of the 'healthcare.gov' site. There is need to enrich

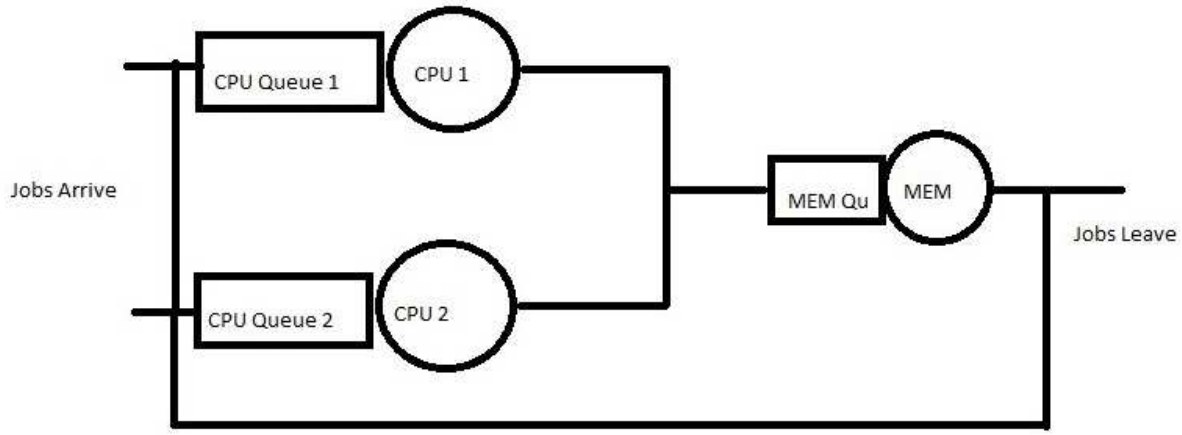


Figure 1. A simplified Queueing Network Model of non-virtualized computing system

the computer science curriculum with materials focused on performance and capacity and a research effort converging towards an unified scientific approach to solve the problem of modeling virtualized systems and developing programs for optimized performance in a virtualized system.

The emphasis on algorithmic complexity analysis of programs does not include the scalability behavior of various units of a computing system. As a result, programs developed for better algorithmic complexity does not produce the intended result when integrated with systems that has legacy modules causing latency delays in the computing units due to bursts of disk read write or sudden increase in latency due to movement of a virtual machine from one physical system to another physical system. The effects of hypervisor or virtualization layer interference during application runtime has to be considered when developing softwares. The effort to improve the curriculum of computer science has to be futuristic and strategic. A strategic goal will include technical know-how that provides the training and understanding of the general behavior of computing systems as a science. For example, the skill to work in aviation doesn't require to focus on aircrafts built by Boeing or Airbus Industries. Neither is it necessary to focus on turbo propellers or jet engines. All of these are encompassed in the study of science of fluids.

Surprisingly even for comprehending a generalized behavior of computing systems, study of fluid is very important. There are many mathematical theories and tools available for solving problems that arise in fluids. In this paper, analogies between fluid motion and computing systems are demonstrated to emphasize the potential for applying the science of fluid motion for modeling computing systems. In the next section, a generic virtualized computing system is briefly described. Next, some characteristics of gas and liquids are identified and their similarity in the area of computing systems is described. After that, a generalization of Little's law as a partial differential equation (PDE) to model dynamic computing system is described.

2. VIRTUAL COMPUTING SYSTEMS

A virtual computing system is also termed as Virtual Machine (VM) in VMware, Partition or LPAR in IBM AIX platform, KVM in Redhat, Power V in Microsoft etc. The common architectural theme in all of them is to put soft or logical or virtual boundaries around slices of CPU, Memory, Disk and Network Bandwidth to run multiple Operating systems (OS) simultaneously in the same physical hardware box. This is achieved by creating a middleware between OS and hardware. The middleware traps machine level instruction issued from the OS and then translates them suitably before scheduling them to the hardware. The middleware creates controls around the time slices of the physical resources accessed by the application through a virtual system. A VM offers a computing environment to install a standard OS like LINUX, UNIX, Windows etc. and then run applications built for those OS environments.

In Figure 2, a physical box with two computing units (CPU1 and CPU2), a memory system and a disk system is shown. Access to physical resource is controlled by a middleware called hypervisor layer that also implements the VMs or the boundaries around VMs. LINUX OS is installed in VM1 and it is hosting an application server as APP1. A UNIX OS is installed in VM2 and it is hosting a web server as WEB1. Similarly Windows OS is installed in VM3 and VM4 and they are hosting a database cluster as DB1 and DB2. In pre-virtualization setup, it would have required four physical boxes and only 25% of each boxes would have been utilized. In a virtualized system, all four can be running on the same physical box and using 100% of the box instead of wasting 75% capacity of each of four physical boxes in non-virtualized systems.

The size of the resource slices are decided by configura-

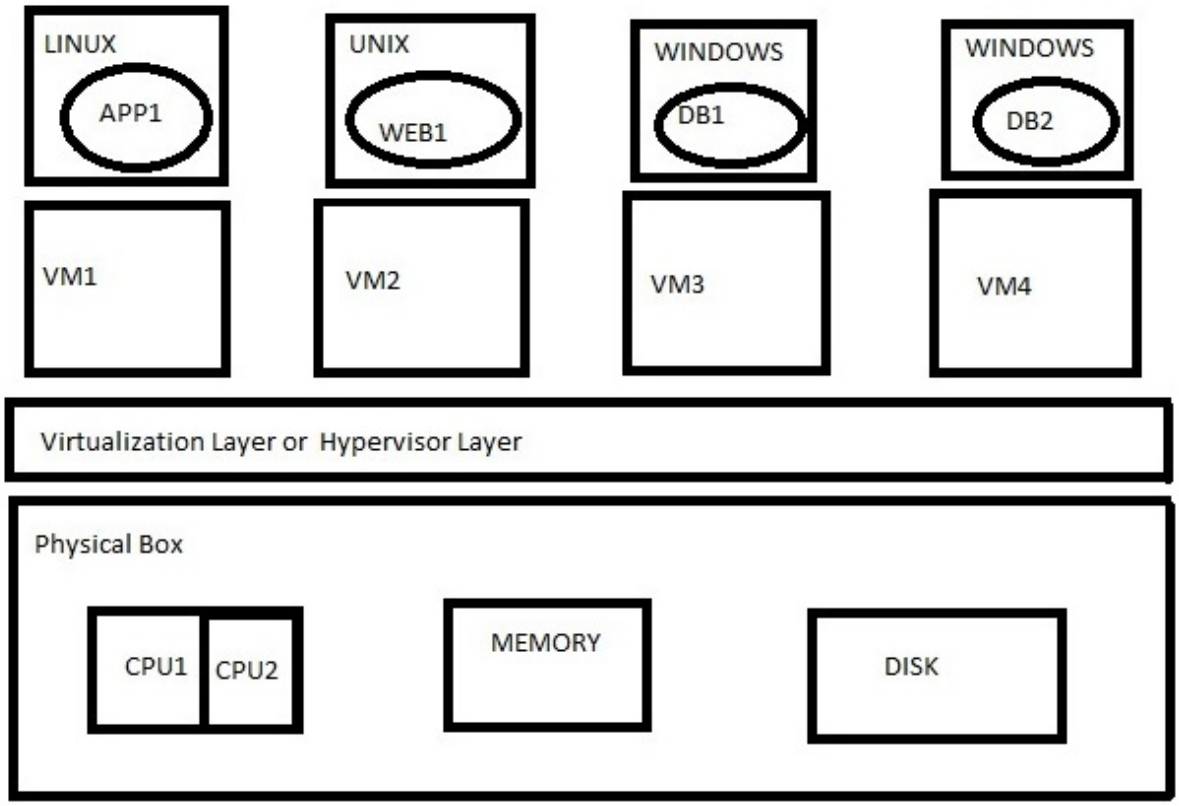


Figure 2. A Box chart view of virtualized system

tion values specified by the system administrator. Usually the configuration of a VM is controlled by numerical values assigned to variables that determine maximum hardware resource that can be accessed by a VM, minimum hardware resource that must be always available to a VM and a share to resolve contention between VMs for shared hardware resource by imposing proportional share.

Pre-virtualization systems had hardware and an OS to interact with the hardware. Applications were compiled and built into machine readable instruction for execution by the OS. In virtualized systems, the OS is interacting with the hardware through the middleware or hypervisor layer. From the OS perspective, there is no difference in running in a VM or in a physical system. The VM boundaries are imposed by the hypervisor, which enforces isolation of various simultaneous OS executions in the same hardware.

In cloud computing environment, a VM is a cloud computing node. Additionally special programs can be installed in the VM to enforce specific cloud computing rules to better manage the cloud computing environments.

3. DERIVATION OF PDE FROM LITTLE'S LAW

If steady state condition is not valid then the variables N, W and λ in Little's law will be varying. The system dynamics in that state can be modeled by deriving a PDE whose solution is Little's law.

Throughput as dependent variable

A service level agreement(SLA) usually contains the required wait time and the number of total concurrent jobs. So, if W and L are treated as independent variables then the throughput λ, according to Little's law in Eq.(1), can be expressed as:

$$\lambda = \frac{N}{W}. \tag{3}$$

Taking partial derivatives of λ with respect to L and W, the following PDE can be obtained:

$$\frac{\partial \lambda}{\partial W} = -\frac{N}{W^2}, \frac{\partial \lambda}{\partial N} = \frac{1}{W}.$$

$$\Rightarrow \frac{\partial \lambda}{\partial W} + \frac{N}{W}\frac{\partial \lambda}{\partial N} = 0 \Rightarrow \frac{\partial \lambda}{\partial W} + \lambda \frac{\partial \lambda}{\partial N} = 0. \tag{4}$$

The above Eq.(4) is a familiar form of nonlinear first order wave equation:

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} = 0, \tag{5}$$

where u is the displacement of the medium, t is the time and x is space in one dimension.

3.1. Response time as dependent variable

If response time, W is considered as the dependent variable then Little's law in Eq.(1) can be expressed as

$$W = \frac{N}{\lambda}. \tag{6}$$

Taking partial derivatives of W with respect to N and λ in Eq.(6), the following PDE can be obtained:

$$\frac{\partial W}{\partial \lambda} = -\frac{N}{\lambda^2}, \ \frac{\partial W}{\partial N} = \frac{1}{\lambda}.$$
$$\Rightarrow \frac{\partial W}{\partial \lambda} + \frac{N}{\lambda}\frac{\partial W}{\partial N} = 0 \Rightarrow \frac{\partial W}{\partial \lambda} + W\frac{\partial W}{\partial N} = 0. \tag{7}$$

The expression in Eq.(7) is again same form as Eq.(5).

3.2. Concurrency as dependent variable

If concurrency, N is considered as the dependent variable then Little's law of Eq.(1) is considered as it is and the partial derivatives with respect to W and λ are

$$\frac{\partial N}{\partial \lambda} = W, \ \frac{\partial N}{\partial W} = \lambda.$$

From the above, the following PDE can be obtained

$$\lambda\frac{\partial N}{\partial \lambda} + W\frac{\partial N}{\partial W} = 2N. \tag{8}$$

The above Eq.(8) is a familiar form of linear first order problem which is a special case of quasi-linear first order problem [5],

$$A(x,y,u)\frac{\partial u}{\partial x} + B(x,y,u)\frac{\partial u}{\partial y} = C(x,y,u), \tag{9}$$

where x and y are independent variables and u is a function of x and y. An interesting form of application is advective transport in a reactive column problem (see chapter 3 of [6]),

$$\frac{\partial C(x,t)}{\partial t} + \hat{v}\frac{\partial C(x,t)}{\partial x} = \pm\xi C(x,t), \tag{10}$$

where x is space, t is time, $C(x,t)$ is the concentration of a species in a fluid, $\hat{v}$ is average advective velocity, and ξ is the rate of accumulation or loss within the element due to reaction. This solution of the equation will predict the stable concurrency level at various combinations of arrival rate and response time.

3.3. Why PDE

There can be various different solutions of a PDE depending on different conditions imposed at the boundary of the domain or the initial state of the system. When a function is integrated then a constant of integral has to be decided for definite integrals. In the same way, boundary conditions or initial conditions for solution of a PDE are used to find the values of the constants of the solution. Thus a function with nice expression may not reveal the actual dynamic interaction of various factors of a system as a PDE does That is why a PDE is a better approach if the fundamental interactive behavior of the interacting terms are to be understood.

4. ANALOGIES

Traditionally gases are considered as fluids. A pipe with gas flowing through it contains gas molecules that are randomly bouncing off the walls of the pipes but collectively moving from one end of the pipes to the other end. There can be variations in the temperature at different sections of the pipe and variation in local gas density due to convection and turbulence in various sections of the pipe. This will also cause change in pressure and volume inside the pipe at various sections. Still, gas and oils flow through pipes installed by utility companies with very little incidents. This means that there are methods to measure and predict the behavior of the distribution system with enough accuracy.

An application executed in a computing system may move from CPU to memory to disk to network port to back to CPU and then leave the system resulting in a web page displayed in some remote device. Like the gas molecules, the application visits (i.e. similar to gas molecules bouncing off the walls) various parts of the system (CPU, memory, disk, network port etc.), form different sizes of queues at different service centers (i.e. similar to different volumes and densities at different sections of a pipe) and then leave the system (ie. as gas molecule leaves through the other end of a pipe).

If pressure buildup becomes uncontrolled then utility pipes burst and some times explode (very rarely though). If the sudden pressure build up is followed by a sufficient period of pressure depression then system will stabilize. Similarly, if too many users try to log into a service pushing the server to its limit then the server will crash. On the other hand if disappointed and annoyed users stop trying to log into a service that is taking very long to respond then it is possible for the server to settle down before tipping the limit.

In liquids, one molecule is connected to many more molecules with some form of weak bonding. In case of water, such weak forces are hydrogen bonding. In case of applications, one program in web layer can cause several different transactions in the data base layer. Interdependency between distributed programs can make one program influence the execution of the other such as by locking or cache miss etc.

Ohm's law states that if the resistance is denoted by R, the voltage is denoted by V and the current is denoted by I then

$$I = \frac{V}{R} \text{ or } V = IR. \tag{11}$$

According to the definition, I is the rate of flow of charge (not electrons) through per unit cross section of the wire per unit time. By definition, V is the work done to move a positive charge from a point at a distance to the point at which the voltage is measured. This implies that the voltage indicates accumulated electric charges at the point of measurement. This is a direct correspondence between the throughput λ of Little's law and the current I of Ohm's law and the concurrency N of Little's law and the volt-

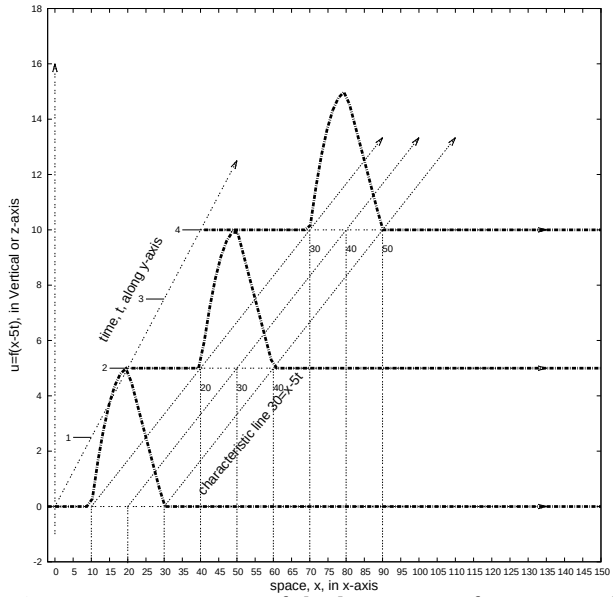


Figure 3. Propagation of the linear wave for $c = 5$ and the initial profile in Eq.(14)

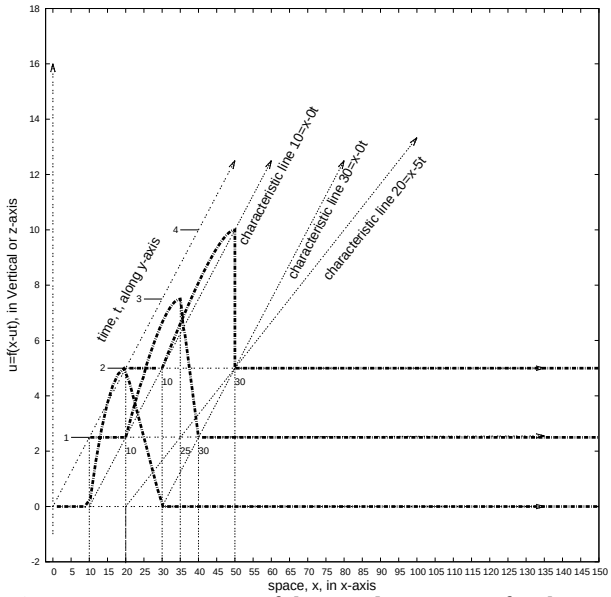


Figure 4. Propagation of the non-linear wave for the initial profile in Eq.(14)

age V of Ohm's law respectively. Trivially the response time W, in Little's law will correspond to the resistance R, in Ohm's law. Little's law relates throughput (transaction/second), wait time (seconds) and the rate of arrival of transactions.

Comparison of Eq.(4), Eq.(7) and Eq.(8) indicate the interaction or balance between the changes of the fundamental dimensions of computing systems. Eq.(5) indicate that if λ is the target function, then W and N of Eq.(4) corresponds to t and x respectively in Eq.(5). On the other hand if W is the target function, then λ and N corresponds to t and x respectively in Eq.(5). In physics, time t increases automatically but in case of performance analysis, neither W in Eq.(4) nor λ in Eq.(7) increase automatically. In practical situation, W or λ can vary but they can both decrease and increase. Wall clock time always increase in physical environment.

5. WAVE PHENOMENA

The expression in Eq.(5) models the surf waves. They are also called nonlinear waves. Briefly the linear waves and nonlinear waves are explained to make the discussion about nonlinear waves self-contained in this work. The expressions are adapted from an undergraduate textbook on PDE [7].

5.1. Linear waves

The equation of linear wave for a constant speed, $c > 0$ is expressed as

$$\frac{\partial u}{\partial t} + c\frac{\partial u}{\partial x} = 0. \tag{12}$$

Let's assume that the initial time, $t_0 = 0$ and at $t_0 = 0$ there was an initial profile that could be modeled by a closed form function, $f(x)$:

$$u(t_0, x) = u(0, x) = f(x). \tag{13}$$

Note that the function, $f(x)$, is a function of space only, because we are assuming that this is the initial deformation of the medium along x. Immediately after this deformation, the counting of time starts. Figure.3 shows a hypothetical initial profile in the domain $x \geq 0$ where $f(x)$ is defined as:

$$f(x) = \begin{cases} -0.05(x-2)^2 + 5 & \text{for } 10 \leq x < 20 \\ -0.5(x-20) + 5 & \text{for } 20 \leq x < 30 \\ 0 & \text{for } x \leq 10 \text{ or } x \geq 30. \end{cases} \tag{14}$$

In Figure.3, if the reference frame were moving at the speed c along $x-$axis tracing the characteristic lines $\xi = x - ct$ for various $x-$intercepts, indicated by ξ, then the points of the profile will appear stationary in those moving reference frames. The characteristic lines for $\xi = 10, \xi = 20$ and $\xi = 30$ are shown in the Figure.3.

5.2. Nonlinear waves

It is important to understand the solution of linear waves of Eq.(12) to understand the implications of the solution of Eq.(5). The speed c, in Eq.(12), is replaced by u in Eq.(5). This implies different speed at different points of x in the initial profile. Figure.4 shows a picture of the solution of Eq.(5) for the initial profile of Eq.(14). The practical example of this type of solution is the surfing wave. The speed of small linear waves get slower as they approach the shore

line. As a result, a combined state of several small linear waves are reached where each elevation point of the water surface forming the waves will move towards the shore at different speeds. Higher the elevation, higher is the speed of the point. As a result, a shock state is arrived where the top of the wave is vertically at the top of a water wall formed by the wave and right after that point the water from the top of the wave starts to fall over the water wall and the wall starts to cave in and fall towards the shore. In Figure.4, each point of x at $t = 0$ can be considered as a linear wave with a different speed.

The only case where the speed can be constant is if the initial profile is

$$f(x) = K,\ K \in R \text{ is a constant.} \tag{15}$$

The initial profile of Eq.(15) implies that the domain of the Little's law of Eq.(1) for average throughput and average concurrency under steady-state flow assumption is possible only in the interval of concurrency where the response time, W, is constant. A direct analogy with the surf wave can be made in the case of queueing network. The violation of steady state flow condition implies that either more number of requests are arriving than the number of requests leaving the service center or less number of requests are arriving than the number of requests leaving the service center. If more requests are arriving than leaving, then a condition similar to the slowing of linear waves, approaching the shore, is created. Eventually the queue starts to build and the shock starts to happen when the queue becomes full and arriving requests are dropped.

6. CONCLUSION

The significance of reorganizing computer science curriculum to face the future challenges in the area of performance modeling and capacity planning is described. In an effort to help decide a possible right course of change in the computer science curriculum the inherent relation between the study of fluid motion and some fundamental behaviors of computing system is explained. Mathematical expressions of dynamic computing systems in the form of partial differential equations derived from Little's law is shown. The type of mathematical skills needed to be successful in transforming computing system problems into problems in fluid motion and finding solution is shown by explaining the first order nonlinear wave equation.

REFERENCES

[1] A. O. Allen, **Probability, Statistics and Queueing Theory with Computer Science Applications,** 2nd Edition, San Diego, CA, Academic Press, ISBN 0120510510, 1978.

[2] E. D. Lazaoska, J. Zahorjan, G. S. Graham and K. C. Sevcik, **Quantitative System Performance Computer System Analysis Using Queueing Network Models,** Prentice-Hall Inc. ISBN-13: 978-0137469758, 1984.

[3] C. J. DePasquel, "Capacity Management in VMware Environments - Allocation vs Demand", Performance and Capacity Conference by CMG., 2013.

[4] M. Friedman, "Management in the Virtual Center:Virtual Memory Management", Performance and Capacity Conference by CMG., 2013.

[5] P. L. Sachdev, **Self-Similarity and Beyond: Exact Solutions of Nonlinear Problems,** CRC Press ISBN 9781584882114.

[6] A. P. S. Selvadurai, **Partial Differential Equations in Mechanics 1,** ISBN 978-3-642-08666-3 (Print) 978-3-662-04006-5 (Online).

[7] P. J. Olver, **Introduction to Partial Differential Equations,** Springer-Verlag, ISBN-10: 3319020986, 2012.

Using an Interdisciplinary Course to Teach Intercultural Communication: Helping Students and Faculty Bridge Disciplinary Divides

Dr. Madelyn Flammia
Department of English
University of Central Florida
Orlando, FL 32816 USA

Dr. Houman Sadri
Department of Political Science
University of Central Florida
Orlando, FL 32816 USA

ABSTRACT

There is great value in helping students bridge both cultural and disciplinary divides as we prepare them for the challenges of citizenship in the twenty-first century. This paper describes, Global Perspectives, an interdisciplinary course taught by a faculty member in a technical communication program together with a faculty member in a political science department. The course focused on issues of power and communication as they relate to global issues: world hunger, environmental concerns, world health, and human rights. Through this course, the faculty members addressed a major concern in higher education today: the need to educate students to be global citizens capable of meeting the serious challenges facing the world in the 21st century. This concern is relevant for all college students regardless of their majors.

Keywords: disciplinary divide, global citizenship, intercultural communication, interdisciplinarity, international education, team teaching, transdisciplinarity

INTRODUCTION

Due to recent developments in telecommunications and technology, today's students will face an increasingly globalized workplace when they graduate from college. They will also face the challenge of functioning as citizens in a global society. There has never been a greater need for effective communication and cooperation among the peoples of the world than there is at the present time. In response to the increasingly global nature of society, a new concept of citizenship has arisen, the concept of global citizenship.

A global citizen is someone who understands the relationship between global and local events [1]. Global citizens are sensitive to cultural difference and know how to communicate effectively with diverse others [2]. In addition to understanding the need to communicate across cultures, global citizens are also aware of the need to address challenging world issues from an interdisciplinary perspective.

There is great value in helping students bridge both cultural and disciplinary divides as we prepare them for the challenges of citizenship in the twenty-first century. Experiential learning is an effective means for preparing students for the challenges they will face both in the workplace and in their lives outside of work [3]. Since 9/11 there has been recognition of the need for American college students to have greater international awareness and better knowledge of other cultures [4]. Gacel-Avila states that institutions of higher education are charged with the responsibility of "fostering a global consciousness among students" [5]. The development of an interdisciplinary course team taught by faculty from technical communication and international relations serves the purpose of expanding students' global awareness generally at the same time that it imparts the specific knowledge and skills needed to internationalize documentation.

A TYPOLOGY OF INTERDISCIPLINARITY

Generally speaking, "interdisciplinarity is the integration of existing disciplinary perspectives" [6]. An interdisciplinary course is one that is grounded in more than one discipline; such a course may be team taught by instructors from two or more fields. In an empirical study of interdisciplinary research and teaching, Lattuca derived a typology of four different forms of interdisciplinarity: informed disciplinary, synthetic interdisciplinarity, transdisciplinarity, and conceptual interdisciplinarity [7]. *Informed interdisciplinary* is instruction focused on a single discipline that calls upon other disciplines to enhance course content. For example, an instructor teaching a course in visual design in technical communication may include discussion of the fields of graphic design, fine arts, and film.

Synthetic interdisciplinarity involves instructors from two distinct disciplines working together to combine the theories, concepts, and research methods from the two disciplines. The two disciplines still remain distinct from one another, but the instructors demonstrate areas where the two overlap and influence one another. The course described in this paper is an example of synthetic interdisciplinarity where instructors from two distinct disciplines (technical communication and international relations) combine theories related to communication and power while at the same time instructing students in the distinctive methods of inquiry used in each field.

Transdisciplinarity is an approach that does not focus on the disciplinary sources of theories and methods, but rather applies them across disciplines. A course that applied one overarching theory of learning across all disciplines and tested that theory in the realm of various distinctive disciplines would be an example of transdisciplinarity.

Finally, *conceptual interdisciplinarity* is an approach that explores a topic from the perspective of multiple disciplines without privileging any disciplinary perspective(s). For example an instructor might have students explore different theories of how humans learn from the perspective of various disciplines and then encourage the students to critique the theories and note their limitations. This approach is consistent with postmodern and feminist inquiry methods that suggest all questions should be answered from an interdisciplinary perspective.

GLOBAL PERSPECTIVES: A SYTNHETIC INTERDISCIPLINARY COURSE

The course described in this paper, Global Perspectives, was a synthetic interdisciplinary course taught by a faculty member in a technical communication program together with a faculty member in a political science department. The course focused on issues of power and communication as they relate to global issues: world hunger, environmental concerns, world health, and human rights. The faculty members sought to broaden students' perspectives while at the same time strengthening core skills, such as critical thinking, problem solving, and reflective judgment. Research on situated learning theories suggests several benefits from having students address complex real-world problems because they require students to engage in activities like the ones they will have to perform in the workplace. When doing so, students develop problem-solving and critical thinking skills [8].

The majority of the students enrolled in Global Perspectives were majoring either in English/Technical Communication or Political Science/International Relations. There were also a few students from other majors like liberal arts, business, and communication.

The instructors sought to increase students' global awareness and also help them understand the role played by political power and effective intercultural communication in addressing these issues. In addition to the general knowledge that all students would get from the course, for the technical communication students the emphasis was on improving their knowledge of international issues and world events and their intercultural communication skills. For the international relations students, the emphasis was on improving their written communication skills.

An Improved Understanding of International Audiences

The better understanding writers have of their audience, the more effective their documents will be. When writing for international audiences, students must have an understanding of intercultural communication. Instead of merely introducing students to various concepts drawn from the field of intercultural communication, however, the instructors in the Global Perspectives course sought to contextualize the study of intercultural communication and to give assignments that would require the active participation of students in addressing global issues.

In line with the desire to fashion a higher education curriculum that develops global citizens, the instructors began the course with discussions of global issues facing the world today. Although the instructors wanted the students to develop knowledge and skills relevant to their professional careers, first and foremost, they wanted students to develop those skills in a broad context not limited by boundaries of disciplines or borders between nations.

To this end, instead of having students learn specific facts about other cultures and then apply them to their own disciplines, the instructors began with the big picture and let students direct precisely how it would be narrowed down and what specific aspects of intercultural communication would be emphasized. Offering students choices and allowing them to guide the class discussion can increase their motivation and interest [9].

The course began with a discussion of what students felt were the key issues that affect all people in the world. The issues they mentioned were the environment, terrorism, world health, world hunger, and human rights. After each instructor gave an introductory lecture related to his/her respective discipline, students were then asked to discuss how they thought issues of power and issues of communication impacted the global issues they had previously identified. This discussion naturally led the class to examine the importance of understanding power and power differentials in relationships and also to focus on the importance of effective and unambiguous communication among members of different cultures.

As the semester progressed, students were given a series of lectures by their instructors that developed these topics in more detail in relation to the fields of international relations and technical communication. In conjunction with the lectures, students were also given a series of assignments that required them to select one of the global topics identified and research it in greater detail. These assignments included an internet research assignment, a field research assignment, an audience analysis assignment, and a documentation project for an international audience.

Internet Research Assignment

For the internet assignment, students were required to find three relevant sources online that would help them further develop their understanding of one of the global issues being discussed in class. Students were given strict guidelines regarding which sources would be acceptable for this assignment. The purpose of this assignment was for students to become familiar with particular online resources related to global issues. This initial research also prepared students for the next assignment, the field research assignment.

Although internet research is nothing new to undergraduate students, this assignment was defined in such a way as to challenge students to go beyond their typical approaches (using a search engine like Google) and to expand their knowledge of databases for international research. Students were introduced to the vast array of electronic resources available for conducting international research. The University of Central Florida has an extensive and well-organized collection of electronic resources for international research.

The assignment also served to introduce students to research in another discipline. For this assignment, the students were required to find and analyze sources from outside their field of study. For example, students used sources like World News Connection, Columbia International Affairs Online, and The Public Affairs Information Service (PAIS) to gather understanding of a particular cultural group.

Field Research Assignment

The field research assignment built on the internet assignment. Like the internet assignment, the field research assignment was designed to prepare students for the documentation project. Once the students had done some background research on their topic, they were given the field research assignment, which required them to go into the community outside the university to gather more specific information related to some aspect of the topic they explored in their internet research. In many cases, they would also become aware of a local connection to their topic when doing the field research assignment.

The students had a choice of either conducting an interview or attending the meeting of professional or service organization. When this assignment was given, students received a list of local consulates, businesses, and other organizations relevant to their research. In response to the assignment, students interviewed community and business leaders and attended meetings of organizations that included the Barbados Club of Central Florida, the Metro Orlando Economic Development Commission, and the International Visitors Council of Orlando. Students were required to write up the information they gathered from their field research and relate their findings to one particular global issue.

For example, the student who attended a meeting of the Barbados Club of Central Florida identified a need for better communication among members of the community of Barbadians living in Central Florida. She determined that it was important to build the community for several reasons: 1) it would provide social support for individuals recently relocated to Central Florida; 2) it would help organize and focus efforts by Central Floridians from Barbados to maintain contact with and to support the communities they left behind in Barbados; 3) it would help organize and focus efforts to raise awareness of the nation of Barbados and its culture and heritage (typically Barbados is only thought of as a tourist destination) within their community, Florida, and ultimately the United States. To meet these purposes, she decided to create a newsletter for the Barbadian community within Central Florida.

Audience Analysis

Once the students had begun to develop a more thorough understanding of the global issues they had chosen to research, they were challenged to develop a documentation project related to that topic for a specific audience. For example, a student researching environmental issues might choose to create a brochure to raise awareness of the issues among college students internationally. Once the students had developed an idea for a project, they were then required to analyze one audience for their document. For example, the student who wanted to raise the awareness of college students regarding environmental concerns might choose to begin by addressing college students in Mexico and the United States.

The first step in creating documentation for any audience either domestic or international is to analyze the audience for that documentation. In conjunction with the audience analysis assignment, students learned about cultural variables and how to study them in order to understand audiences in other cultures. The specific cultural variables studied were the seven presented by Nancy Hoft in *International Technical Communication*: political, economic, social, religious, educational, linguistic, and technological [10]. Examining these variables naturally included a discussion of issues of power from the perspective of international relations (political, economic, social, and religious) and of issues of effective communication from the perspective of technical communication (educational, linguistic, and technological). Of course, the discussion of the variables was not rigidly divided between the two disciplines. However, some variables, such as politics and economics, obviously lent themselves to discussing power; others, like education and linguistics, were relevant to concerns about effective communication.

Further, although students were expected to include a discussion of all seven variables in their audience analysis, they were not limited to these seven variables. They were also urged to include any other variables that they felt would be appropriate for the audience and the subject they were focusing on in their project. For example, students examining global health issues chose to include health as a variable because they wanted to understand cultural differences in attitudes toward health care and traditional and alternative medicine among members of their target audience. Once the students completed their audience analysis they were ready to write a proposal describing their plans for the documentation project.

A Documentation Project for an International Audience

The major project for the course was to produce a documentation project for an international audience. The instructors defined an international audience as any group of readers that included at least some members of another culture (outside the U.S. culture). Because of the way an international audience was defined, some students did projects for members of one other culture, some students did projects for an audience composed of members of several other cultures, and some students did projects targeted both to members of another culture and to members of the U.S. culture. For example, one student created a guide for business people in the United States and Germany who wished to work with one another. Another student created a web site on environmental issues targeted to an audience in Norway.

The guide for business people focused on the basics of intercultural communication in the first section and then went on to provide specific information targeted to communication issues likely to arise between U.S. and German business people. It discussed the verbal communication styles and business practices of the two nations, and also gave advice regarding differences in expectations regarding business etiquette, nonverbal communication, and negotiation strategies.

The web site offered practical suggestions for environmentally conscious citizens in Norway; it gave advice about water conservation, waste disposal, and fuel conservation. The purpose of the site was to enable to the average citizen to take action to help preserve the environment. The site also gave contact information for key environmental organizations and government agencies both in Norway and in Europe.

The purpose of the documentation project was twofold: 1) it required that students translate their general understanding of a global issue into a small, but relevant, contribution to addressing that global issue; and 2) it required that students put into practice their enhanced communication skills, particularly their understanding of effective intercultural communication.

The student projects addressed a wide range of issues, some of which were more focused and defined than others, but all of

which addressed some aspect of improved intercultural understanding. Several of the projects were geared toward preparing business people to communicate effectively across cultures. Others focused on preparation for citizen diplomacy. Many of the projects also addressed global issues such as the environment, world hunger, and international adoption.

BENEFITS AND OUTCOMES FOR STUDENTS

The students benefited by developing an expanded awareness of global issues at the same time they strengthened core skills in problem solving and critical thinking. They also developed documentation projects to include in their professional portfolios.

Benefits of Interdisciplinary Courses for Students

Much research still remains to be done on interdisciplinary teaching and learning. However, existing research suggests numerous benefits associated with interdisciplinary courses. Interdisciplinary courses can enhance learning by facilitating the acquisition of new information. New information is learned by linking it to previous knowledge held in the learner's memory; a learner's previous knowledge and the activation of that previous of knowledge will affect the acquisition of new knowledge [11]. Interdisciplinary courses enhance student learning because they provide students with more opportunities to connect new information with existing knowledge by calling upon disciplinary information and challenging students to relate it to new concepts and ideas [12].

Interdisciplinary courses that introduce real-world problems, like the global issues addressed in the course described in this paper, create meaningful contexts for study and help prepare students for the types of tasks they are likely to encounter in the workplace. Such courses are likely to help students develop their problem-solving and critical and reflective thinking skills. Interdisciplinary courses that challenge students to address global issues also help students develop comprehensive perspectives. Davis has argued that "students in an information society need to develop the capacity to cope with multiple perspectives on issues and problems" [13]. Interdisciplinary courses help them learn to "see, evaluate, and select from among differing perspectives that bear on a problem" [14].

Further, several studies have also suggested that student motivation and interest is likely to be higher when students have the more sophisticated views of knowledge that are encouraged by interdisciplinary study [15]. Certainly, the students in Global Perspectives exhibited a great deal of interest in learning about global issues and intercultural communication; their motivation was evidenced by their work on their documentation projects as well as in other student outcomes from the course.

Student Outcomes

Although their attitudes and competences were not measured, the students in Global Perspectives did display a high level of motivation. When the course is taught again, the instructors plan to conduct an empirical study in which changes in students' attitudes and development in the students' critical thinking skills are measured.

While the results discussed here are anecdotal, they are strongly indicative of very positive outcomes for the students; the overall course evaluations for both instructors were well above their departmental and college averages. The scores for the students' self-reported assessment of the value of the course to their professional careers and their assessment of the improvement in their critical thinking skills as a result of taking the course were particularly high.

The students took on many challenging documentation projects which required that they use problem-solving and critical thinking skills. The success of their projects is some indication of the benefits they derived from the course. In many cases, the projects that students produced were, in fact, service-learning projects—although a focus on service-learning was not explicitly included in the course. One student project included a PowerPoint presentation on intercultural communication for business people working abroad that was adapted for use by the training department of a local corporation. This student was already working part time for DSE Corporation. She created a PowerPoint presentation offering an introduction to key issues in intercultural communication for employees going on assignments abroad. The PowerPoint included general information, but was also customized to present information on specific locations where many of the corporation's employees were likely to travel. Like the project for DSE Corporation, many of the projects were produced and used by their intended audiences, for example, the newsletter for the Barbados Club of Central Florida.

Further, as a result of taking the class many of the technical communication students were inspired to pursue further study of other cultures. Some students pursued additional foreign language courses, others chose to study abroad, and still others sought out and were granted internships with multinational corporations and government agencies.

The students majoring in Political Science/International Relations developed their communication skills as well as their knowledge of document design and production. They reported a new respect for individuals who prepare instructional documentation and web sites. Many of them also expressed the belief that their enhanced communication skills would be an asset in their future careers. Nearly all of them planned to use the documentation project as a writing sample to show prospective employers.

BENEFITS FOR FACULTY

The experience was just as educational for the instructors as it was for the students. Most institutions that offer interdisciplinary courses and programs, including widely recognized programs like Miami University's School of Interdisciplinary Studies, have faculty with traditional postgraduate training (i.e., focused primarily if not exclusively in one discipline). For most faculty involved in team-teaching interdisciplinary courses, initial exposure to the perspectives of the other disciplines comes through committee meetings in which courses are designed and by reviewing the readings suggested by other faculty. Much of the command of the other discipline's perspectives is developed as the course is taught [16]. The two instructors who taught the course described in this paper were typical in that each learned about the other's field as they were teaching the course.

In addition to learning more about each other's fields, the instructors benefited from exposure to each other's methods of lecturing, structuring and responding to assignments, and monitoring class discussions. Frequently, certain methods are

used more in some disciplines than in others. For example, the technical communication faculty member used peer reviewing and project proposals in the course; these methods were not ones typically used by the international relations faculty member. Conversely, the international relations faculty member used discussion questions from assigned reading to structure in-class discussions; this methodology was not typically used by the technical communication faculty member.

While none of the methods are in any way discipline specific, by using a wider range of methods, the instructors enhanced students' educational experience, and both faculty members enlarged their repertoire of classroom methodologies. Instead of merely seeing the methodologies as something related to another discipline, both faculty members adapted them to other classes they teach within their own disciplines. Their experience is consistent with a report by Frost and Jean on a research study conducted at Emory University; the study, funded by a Henry Luce Foundation grant, examined discourse across scholarly boundaries. Frost and Jean report that about half the teachers who participated in the study altered their teaching styles and techniques based on their exposure to interdisciplinary discourse [17].

The study also found that the influence of interaction with scholars from other disciplines had a significant influence on faculty motivation. Participants in the study reported that they had increased motivation for their scholarly work as a result of interdisciplinary discourse [18]. The faculty members who taught Global Perspectives have gone on to co-author a scholarly book as a result of their experience teaching an interdisciplinary course together. The experience has also stimulated and broadened their individual research efforts.

The biggest drawback was that both instructors felt it was difficult to introduce students to the concepts of two very different fields in one brief semester while also having them produce a major documentation project. The challenge was most pronounced for students who were neither International Relations nor Technical Communication majors. Students who were majoring in one or the other field and were juniors tended to have fewer difficulties with the assignments than those students who were non-majors. This suggests that interdisciplinary courses may work better when students have a basic familiarity with at least one of the two fields being taught.

BENEFITS TO THE CURRICULUM

In general interdisciplinary courses provide students with a richer experience of their major field of study and help them develop the ability to see important connections that cross disciplines. Students develop a broader perspective on knowledge and improve their problem-solving and critical thinking skills. In many cases, they may also have a higher level of interest and engagement in the course.

The particular course described in this paper addressed a major concern in higher education today: the need to educate students to be global citizens capable of meeting the serious challenges facing the world in the 21st century. This concern is relevant for all college students regardless of their majors. Beyond the general concern, this course addressed the need to further internationalize the curriculum, particularly for the technical communication students. It greatly enhanced technical communication students' knowledge of intercultural communication specifically as it applies to audience analysis for international documentation projects. Further, the course helped all the students develop their ability to understand the role of effective communication and power issues in addressing global concerns as well as their ability to view these concerns from a perspective that is not restricted by one discipline or by national boundaries.

CONCLUSION

There is no doubt that interdisciplinary courses provide many far-reaching benefits for students and faculty, and that such courses have the potential to greatly expand and internationalize the curriculum at institutions of higher education. When developing such courses it is useful for us to think beyond our tradition notions of which fields might complement one another. For example, many existing courses pair students in technical communication with students in engineering and science. While such collaboration has obvious value, there is also a need to expand our notions of interdisciplinarity and to seek out collaborations that span a wide range of disciplines which complement and inform our fields. Such partnerships have the potential to enhance the experiences of students and faculty, as well as to contribute to a richer curriculum that addresses the challenges of the modern workplace and of global citizenship in the 21st century.

REFERENCES

[1] C.R. Stevens and P.J. Campbell, "Collaborating to Connect Global Citizenship, Information Literacy, and Lifelong Learning in the Global Studies Classroom," **Reference Services Review**, Vol. 34. No. 4, 2006, pp. 536-556.

[2] H.H. Hobbs, H. H. and H.I. Chernotsky, "Preparing Students for Global Citizenship," **Proceedings of the American Political Science Conference**, February 2007.

[3] I. K.P. Fortuin and S.R. Bush, "Educating Students to Cross Boundaries between Disciplines and Cultures and between Theory and Practice," **International Journal of Sustainability in Higher Education**, Vol. 11, No. 1, 2010, pp. 19-35.

[4] L. Siaya, M. Porcelli, and M.F. Green, **One Year Later: Attitudes about International Education since September 11**, American Council on Education Public Opinion Poll, American Council on Education, Washington, DC, 2002; V. Clarke, "Students' Global Awareness and Attitudes to Internationalism in a World of Cultural Convergence," **Journal of Research in International Education**, Vol. 3, No. 1, 2004, pp. 51-70.

[5] J. Gacel-Avila, "The Internationalisation of Higher Education: A Paradigm for Global Citizenry," **Journal of Studies in International Education**, Vol. 9, No. 2, 2005, pp. 121-136.

[6] L.R. Lattuca, L.J. Voigt, and K.Q. Fath, "Does Interdisciplinarity Promote Learning? Theoretical Support and Researchable Questions," **The Review of Higher Education**, Vol. 28, No. 1, 2004, pp. 23-48.

[7] L.R. Lattuca, **Creating Interdisciplinarity: Interdisciplinary Research and Teaching among College and University Faculty**, Nashville, TN: Vanderbilt University Press, 2001, pp, 81-98.

[8] B. Rogoff, **The Cultural Nature of Human Development**, New York, NY: Oxford University Press, 2003.

[9] P.R. Pintrich and D.A. Schunk, **Motivation in Education: Theory, Research, and Applications**, Englewood Cliffs, NJ: Prentice-Hall, 1996.

[10] N.L. Hoft, **International Technical Communication: How to Export Information about High Technology**. New York, NY: John Wiley & Sons, Inc., 1995.

[11] T. Schuell, "Cognitive Conceptions of Learning," **Review of Educational Research**, Vol. 56, 1986, pp. 411-436; J.D. Bransford, A.L. Brown, and R.R. Cocking, **How People Learn: Brain, Mind, Experience, and School**, Washington, D.C.: National Academy Press, 2000.

[12] L.R. Lattuca, L.J. Voigt, and K.Q. Fath, "Does Interdisciplinarity Promote Learning? Theoretical Support and Researchable Questions," **The Review of Higher Education**, Vol. 28, No. 1, 2004, pp. 23-48.

[13] J.R. Davis, **Interdisciplinary Courses and Team Teaching: New Arrangements for Learning**, Phoenix, AZ: American Council on Education/Oryx Press, 1995.

[14] J.R. Davis, **Interdisciplinary Courses and Team Teaching: New Arrangements for Learning**, Phoenix, AZ: American Council on Education/Oryx Press, 1995.

[15] L.R. Lattuca, L.J. Voigt, and K.Q. Fath, "Does Interdisciplinarity Promote Learning? Theoretical Support and Researchable Questions," **The Review of Higher Education**, Vol. 28, No. 1, 2004, pp. 23-48; S. Öncu and Z. Özdilek, "Learning with Peers: An Interdisciplinary Comparative Study of Learner Interaction and Satisfaction on an Instructional Design Course," **KURAM VE UYGULAMADA EGITIM BILIMLERI**, Vo. 13, No. 2, 2013, pp. 1251-1261.

[16] W. H. Newell, "Academic Disciplines and Undergraduate Interdisciplinary Education: Lessons from the School of Interdisciplinary Studies at Miami University, Ohio," **European Journal of Education**, Vol. 27, No. 3, 1992, pp. 211-221.

[17] S.H. Frost and P.M. Jean, "Bridging the Disciplines: Interdisciplinary Discourse and Faculty Scholarship," **The Journal of Higher Education**, Vol. 74, No. 2, 2003, pp. 119-149.

[18] S.H. Frost and P.M. Jean, "Bridging the Disciplines: Interdisciplinary Discourse and Faculty Scholarship," **The Journal of Higher Education**, Vol. 74, No. 2, 2003, pp. 119-149.

E-learning experiences in distance learning short courses[i]

Dimitrios A. GIANNIAS
School of Social Sciences, Hellenic Open University,
Patras, 26222 Greece

and

Eleni SFAKIANAKI
School of Social Sciences, Hellenic Open University,
Patras, 26222 Greece

ABSTRACT

Lifelong Learning aims at furthering career opportunities and professional development and encourage adults to appreciate the importance of education to their lives and in the society as a whole. A number of courses such as short, long, summer etc. offer programs which can lead to a qualification; can be used immediately; provide opportunities to explore specialised subjects; offer potential for career development. The distance learning courses which offer all the above opportunities without the need of physical presence are particularly popular since they offer the flexibility to study at the learner's own pace and place and in his convenience. These courses have been benefited largely by the advancement of technology. The present paper will explore two e-learning environments used for short-courses through the method of distance learning organized by the Hellenic Open University. The information and communication was managed in two ways: through a platform which was created using the Moodle virtual learning environment, and through the implementation of publicly available tools such as Google docs and Skype. The performance of both platforms will be explored using a number of variables and conclusions will be exported to provide a basis for further enhancement and improvement.

Keywords: Lifelong Learning, short courses, e-learning, learning platforms.

1. INTRODUCTION

The idea of continuing education or Lifelong Learning (LLL) is widely discussed in the European policy (e.g., [1], [2]). The development and implementation of coherent and comprehensive strategies for LLL has become a central educational goal for the European Union since 2000 [3]. Lifelong Learning is the "ongoing, voluntary, and self-motivated' pursuit of knowledge for either personal or professional reasons [4]. The concept of continuing education aims to address an audience of adult learners, those that passed the traditional university age, who already have some kind of education and plan to continue it. It aims to pursue several issues such as social inclusion, active citizenship, personal development and employability [5].

New technologies made a big difference in education. The online courses have brought the possibility of obtaining an affordable education to many of those to whom it was previously out of reach. The delivery of continuing education is increasingly based on distance learning particularly with the advancement of technology.

Distance learning can include, besides the independent study, material such as cd-roms, broadcast programs, online lectures, conference-type group study to mention just a few of the options now available to the distance learning community and can be used to facilitate learning. As such it is not surprising that the method of distance learning is even more popular nowadays.

E-learning is a term broadly used to describe technology with respect to education which supports learning and teaching. There are many definitions for e-learning, however the term is inclusive of all forms of educational technology such as Web-based learning, computer based learning, virtual classroom and digital collaboration (for an extensive discussion see for example [6]). E-learning can occur in or out of the classroom, it can be self-paced, asynchronous learning or may be instructor-led synchronous learning. Consequently, a lot of discussion has been raised with respect to the potential that the information communication technology offers and whether, if used effectively, provides a significant learning experience for the participant ([7], [8]).

2. AIM OF THE STUDY

The present research aims to extend the research presented in Sfakianaki and Giannias, [9] and investigate further the use of virtual learning environments applied in short courses run in the context of Lifelong Learning by the Hellenic Open University (HOU). More specifically, we will evaluate and compare two different e-learning platforms implemented in a number of short courses.

Previous research undertaken by the authors explored how technology was used to support short courses' participants and how their learning process was enhanced using the Moodle Learning Management System. This system is particularly popular among the education community and it has been used by a number of open universities. The Moodle platform offers a variety of tools to manage and promote learning. It can be used for small and large scale groups, runs fully online courses or supports face-to-face courses (blended learning), includes a variety of activity modules such as forums and databases and enables content and learning assessment (quizzes and assignments) [10].

The main scope of the present paper is to reflect how e-learning tools can be applied and improve the quality of distance learning using any type of e-learning environment. Indeed the research presents findings from the implementation on short courses of the Moodle platform mentioned above but also the implementation of publicly available tools such as Google docs and Skype aiming to evaluate the participants' satisfaction and the programs' effectiveness in attaining its goals. The paper closes with a discussion of the summarized results, further steps and research suggestions.

3. IMPLEMENTATION ON SHORT COURSES OF E-LEARNING ENVIRONMENTS

The research has been undertaken for a selection of short training courses of the Hellenic Open University (HOU) under the research program code EDEL 146. The courses run by the method of distance learning. Two academics member of staff of the HOU had the academic responsibility of the programs.

The main characteristics of the Moodle educational platform mentioned above are that it could satisfy all the needs of the trainees (such as communication with instructors and the program's support stuff, interacting with other participants, on line examination, on line marking, electronic submission of coursework etc.) and distribute to them the training material. Due to these characteristics we name this platform AIEP (All Inclusive Educational Platform) (for an extensive discussion see [9]). Two short courses run through the AIEP platform and addressed basically an audience of teachers who aimed to expand their professional development. The programs addressed the topics of "Total Quality Management" and "Introduction to Management".

In comparison there is a Not All Inclusive Educational Platform (NAIEP) which was offered to eight other continuing education programs. The platform was supported by various means such as Google docs, Dropbox, Skype, e-mail communication, telephone calls, live meetings, etc. The eight programs offered through NAIEP were in the following subjects: "Management", "Marketing", "Total quality management", and "Strategic management". Different kinds of professionals participated in these programs; including teachers.

All courses lasted a few weeks (4-12) and offered sufficient autonomy and freedom to the participant to learn and reflect at their convenience. The programs aimed to support professional development keeping in mind however that the target group had already a significant work load on their everyday life.

For both platforms, the learning environment had to be simple to accommodate all participants' technology and communication knowledge. On average the learners had only basic information technology knowledge judging from their applications. Thus, the scope of the e-learning platforms was to allow the users to successfully complete their course but also introduce them in a friendly environment.

Next we evaluate the performance of the educational platforms which were presented above, as well as the impact of other characteristics of the programs.

4. COMPARATIVE EVALUATION OF E-learning PLATFORMS

In the following we compare the performance of each platform, AIEP and NAIEP, relevant to the following criteria (variables):

- DOUT: the number of participants as a % of the total who did not successfully finish a program
- PSTP: participants' satisfaction from the training program (on the 0-5 scale); this is obtained through a course evaluation questionnaire that the participants fill in at the end of their program
- %PEQ: the number of participants as a % of the total who filled in the program's evaluation questionnaire at the end of the period.
- NAPP: the number of applicants
- REGI: the number of applicants who were accepted and finally registered to attend the program
- %REGI: the number of applicants who were accepted and finally registered to attend the program as a percentage of the number of applicants
- HCOST: the cost of training to participants per hour (for example, HCOST = 1 for a trainee who pays a 100 Euro fee to participate in a 100 hour long program)

We examined the above variables for the following three training periods and the training programs offered within an AIEP and NAIEP (Table 1).

TRAINING PERIOD	NUMBER OF TRAINING PROGRAMS USING AIEP	NUMBER OF TRAINING PROGRAMS USING NAIEP
FALL 2012	0	2
SPRING 2013	1	2
SUMMER 2013	1	4

Table 1: Number of training programs using AIEP and NAIEP

The mean values of the criteria for the periods and types of programs which we consider are given in Table 2.

CRITERIA	NAIEP FALL 2012	NAIEP SPRING 2013	NAIEP SUMMER 2013	AIEP SPRING 2013	AIEP SUMMER 2013
NAPP	122	269	174	240	213
REGI	96	224	141	208	193
%REGI	78,69	83,27	81,03	86,67	90,61
%PEQ	68,75	83,04	56,03	74,04	46,11
PSTP	3,84	3,79	3,70	3,73	3,80
DOUT	0,00	1,79	12,77	1,92	14,51
HCOST	1,76	1,82	2,00	1,90	2,00

Table 2: Variable values for the programs offered in the academic year 2012-2013 *(SOURCE: Hellenic Open University, CODE EDEL 146 training programs)*

For a final and overall evaluation and comparison of AIEP and NAIEP, we scale the values of our criteria, DOUT, PSTP, %PEQ, NAPP, REGI, %REGI, and HCOST, from 0-100, where 100 corresponds to the best value and 0 to the worse.

To obtain the scaled values of the above original variable values:

- We use the following formula (1) for X = PSTP, %PEQ, NAPP, REGI, %REGI:

$$X^* = \frac{(X - Xmin)}{(Xmax - Xmin)} * 100 \qquad (1)$$

- and the following formula (2) for X = DOUT, HCOST:

$$X^* = 100 \quad \frac{(X - Xmin)}{(Xmax - Xmin)} * 100 \qquad (2)$$

Using the above formulas, we obtain the values of the transformed variables in the 0-100 scale, which are given in Table 3 below.

CRITERIA	NAIEP FALL 2012	NAIEP SPRING 2013	NAIEP SUMMER 2013	AIEP SPRING 2013	AIEP SUMMER 2013
NAPP	0	100	64	89	79
REGI	0	100	35	88	76
%REGI	0	38	20	67	100
%PEQ	61	100	27	76	0
PSTP	100	64	0	21	71
DOUT	100	88	12	87	0
HCOST	100	75	0	42	0

Table 3: Scaled variable values for the programs offered in the academic year 2012-2013

Based on the above 0-100 scaled criteria values of the programs offered in the three periods of the academic year 2012-2013, we can compute the performance "score" of each type of platform taking the relevant means from Table 3. These are given in Table 4 below.

CRITERIA	NAIEP FALL 2012	NAIEP SPRING 2013	NAIEP SUMMER 2013	AIEP SPRING 2013	AIEP SUMMER 2013
MEAN PERFORMANCE	52	81	23	67	47
RANK	3	1	5	2	4

Table 4: Evaluation and ranking of the two types of educational platforms used by the programs offered in each semester of the academic year 2012-2013

Table 4 shows that the best, as well as the worse score is that of the NAIEP platform.

For an overall evaluation of the two platforms, we use the figures of Table 4 to obtain the mean score of each platform, which is given in Table 5.

CRITERIA	AIEP	NAIEP
MEAN PERFORMANCE	57	52
RANK	1	2

Table 5: Evaluation and ranking of the two types of educational platforms used by the programs offered in the academic year 2012-2013

We see from Table 5 above that the academic 2012-2013 academic year experience shows that the AIEP is first in the ranking according to the above mean performance criterion and it scores about 10% higher than the NAIEP.

8. CONCLUSIONS

As Finsterwald et. al. [11] state, the current trend of societies is towards knowledge and thus there is a growing need of people for Lifelong Learning. The aim of such education is to continue and further professional development, examine more specialised subjects and new directions, gain a certificate, diploma, postgraduate qualification or even a master's degree. In this respect there is a plethora of courses currently available short, long, summer schools, credited or non-credited, courses for vocational enrichment. These courses are intended to encourage professionals to expand their foundations of knowledge and stay up-to-date on new developments.

In the era of Facebook and Twitter, all teaching methods are questioned and expectations change. Information and communication technology has and will continue to provide new learning experiences to learners. Now more than ever education is affordable and flexible. Distance and online learning become increasingly available. The Massive Open Online Courses (MOOCs) is a reality that addresses a particular type of open online course format which has become very popular and expands rapidly [12].

The present paper presented two different e-learning environments. One is based on the Moodle Learning Management System, the AIEP (All Inclusive Educational Platform). The other is a NAIEP (Not All Inclusive Educational Platform) and was supported which was various means such as Google docs, Dropbox, Skype, e-mail communication, telephone calls, live meetings, etc.

The performance of each platform (AIEP and NAIEP) was examined based on a number of variables such as the number of participants, participants' satisfaction, number of applicants who were registered, the cost of training to participants). The examination was undertaken in the context of three training periods and ten different short courses run by HOU CODE EDEL 146.

The results demonstrated that the mean performance of the programs conducted through the AIEP was better than the NAIEP. However if one looks carefully the intermediate calculations of the different training periods it is realised that it is the NAIEP performance ranked first.

Naturally further investigation is required to make safer conclusions. The question therefore remains as to which is the most appropriate learning environment and perhaps there is no definite answer based on the results of the research. The first

indications show that both platforms can be effective and provide participants' satisfaction. What will be even more interesting will be the real-time testing of both platforms by all participants which will enable further conclusions to be produced. A step further could include the comparison of the presently presented platforms with the environment used in MOOCS.

9. REFERENCES

[1] European Commission, "Strategic framework for education and training", Accessed on 01.10.13 from http://ec.europa.eu/education/lifelong-learning-policy/policy-framework_en.htm, 2010.

[2] OECD, "21st century learning: Research, innovation and policy directions from recent OECD analyses", Accessed on 01.10.13 from http://www.oecd.org/dataoecd/39/8/40554299.pdf, 2008.

[3] Commission of the European Communities, "Memorandum on lifelong learning. Brüssel: Commission of the European Communities", 2000.

[4] Department of Education and Science, "Learning for Life: White Paper on Adult Education", Dublin: Stationery Office, 2000.

[5] European Commission, "Adult learning: It is never too late to learn", Accessed on 01.10.13 from http://eur-lex.europa.eu/LexUriServ/site/en/com/2006/com2006_0614en01.pdf, 2006.

[6] J.L Moore, C. Dickson-Deane and K. Galyen, "E-Learning, online learning, and distance learning environments: Are they the same? ", **Teacher and Teaching Education**, Vol. 14, 2011, pp.129-135.

[7] E. Löfström, and A. Nevgi, "University teaching staffs' pedagogical awareness displayed through ICT-facilitated teaching", **Interactive Learning Environments**, Vol. 16, No.2, 2008, pp.101-116.

[8] B. Rienties, D.T. Tempelaar, P. Van den Bossche, W.H. Gijselaers and M. Segers, "The role of academic motivation in Computer-Supported Collaborative Learning". **Computers in Human Behavior**, Vol. 25, No. 6, 2009, pp. 1195-1206.

[9] E. Sfakianaki and D.A. Giannias, " E-learning experiences: how can technology assist in quality distance learning courses", **ICERI2013**, the 6th International Conference of Education, Research and Innovation Seville (Spain), 18th-20th November, 2013, (in press).

[10] Moodle, Accessed on 01.10.13 from https://moodle.org/, 2013.

[11] M. Finsterwald, P. Wagner, B. Schober, M. Lüftenegger, and C. Spiel, "Fostering lifelong learning e Evaluation of a teacher education program for professional teachers", **Teacher and Teaching Education**, Vol. 29, 2012, pp.144-155.

[12] Department of Business Innovation & Skills, "The maturing of the MOOC, Literature Review of Massive Open Online Courses and other forms of online distance learning", **BIS Research Paper**, Number 130, 2013

[i] This research was undertaken within the framework of the Hellenic Open University research project CODE EDEL 146

To Elluminate or Not to Elluminate? That is the question

Hager KHECHINE

Sawsen LAKHAL

Daniel PASCOT

and

Alphonse BYTHA

Faculté des sciences de l'administration, Laval University, G1V0A6, Quebec, Canada

Abstract— **Using the Unified Theory of Acceptance and Use of Technology (UTAUT), we have tried to find out the factors that could explain the acceptance of Elluminate by business students. A Sample of 167 students enrolled in a management information systems course was obtained. Regression analyses were made to test the hypotheses. Results had shown that the intention to use Elluminate was positively influenced by performance expectancy, effort expectancy and social influence. Performance expectancy was proven to be the strongest predictor of the intention to use Elluminate. Independent variables have explained 43.6% of the variance of the dependent construct. Using the UTAUT model in the educational field is one of the theoretical contributions of this research. University administrators can use obtained results to make an informed choice about the use of the technology in the educational context.**

Index Terms— **Blended learning, Elluminate, Webinar, UTAUT, SPSS.**

I. Introduction

The use of synchronous communication technologies has been gaining more ground both in the educational and the organizational contexts. The last decade witnessed the emergence of a new trend mixing synchronous and asynchronous tools. In the educational context, this trend was known as "Blended learning" (Baehr, 2012). Among the synchronous technologies that were used to support blended learning, organizations and universities have adopted instant messaging, web conferencing, real-time audio and video conferencing, and shared applications. Even though these communication means contribute to enhance collaboration and for some extent learning, their acceptance by users was seldom studied. We deem it essential to explore this question as it was proven that users' resistance to the technology may lead to its failure. The impact of this failure may be fatal because the technologies used for synchronous communications are expensive. The concerned technology here was the webinars and more especially Elluminate. Obtained results may help decision makers in the academic domain to make informed choices about the best mean to support blended learning in order to satisfy more "customers" all over the world.

II. Literature Review

Online learning has been growing exponentially in higher education (Allen and Seaman, 2004; Gosmire et al., 2009) thanks to many advantages that it offers like temporal and spatial flexibility for students, financial benefits for the universities (Gosmire et al., 2009), and effectiveness (Myers and Schiltz, 2012). The most pursued aim of distance learning is academic performance. Some studies revealed that academic performance was higher for online students as compared to those enrolled in face-to- face courses (U.S. Department of Education, 2010). To academic performance, many teachers strive to join students' satisfaction as for those attending face-to-face courses. Some research results highlighted the effect of synchronous interactions in increasing students' satisfaction and improving their learning with online courses (Schubert-Irastorza and Fabry, 2011; Skylar, 2009). Synchronous course delivery mode was proven to improve direct interaction, learning support, and motivation in distance courses (Fabry, 2012; Fearson et al., 2012). Many research results supported these assertions and added to previous advantages flexibility, idea sharing, better communication (Fearson et al., 2011), and students' performance enhancement (Chan, 2011). According to Myers and Schiltz (2012) and Wang and Hsu (2008), these technologies can create a familiar learning environment for online students. The use of synchronous communication tools may contribute to strengthen teacher presence, to allow for instant and clear feedback, to facilitate group decision-making, and to develop a spirit of learning community.

Webinars are an example of these technologies that organizations and universities use to support online training and courses. They enable to transmit video, audio, images, to use whiteboard, and to share applications in real-time, permitting synchronous interactions between all participants. The synchronous communication offered by the webinars permits interactivity through live communication. Furthermore, webinars enable busy students to follow the same course by a later listening to the recordings of the live sessions. These two possibilities are known to significantly decrease the cost of instruction because students don't need to travel to attend classroom sessions.

As the use of webinar technology is relatively new in online courses, research on this synchronous tool in the educational context is not widely available (Myers and Schiltz, 2012; Skylar, 2009; Wang and Hsu, 2008), especially quantitative research. For instance, de Gara and Boora (2006), Myers and Schiltz (2012), and Wang and Hsu (2008) revealed positive impacts of the use of this technology on students' learning. However, to our knowledge, no study has yet spotted the acceptance of this technology by students. The objective of this study was then to: "Find the factors that affect the willingness of students enrolled in university courses to listen to live or recorded webinar sessions". We think that it is important to know why students accept or reject such a technology before expanding its use, especially when it represents a huge investment. This investment will be better allocated if we "act" on the factors behind the acceptance or the refusal.

III. RESEARCH QUESTION, MODEL AND HYPOTHESIS

For the purpose of this research, Elluminate was the webinar system that was used to answer the first research question. This latter was formulated as follow:

"What are the factors that influence the acceptance of Elluminate as a webinar system by students enrolled in an undergraduate university course?"

The research model relied on the Unified Theory of Acceptance and Use of Technology (UTAUT) model (Venkatesh et al., 2003). UTAUT is an integrative and a global model, derived from several known models and theories developed to explain technology acceptance by its users (Ajzen, 1991; Compeau and Higgins, 1995; Davis, 1989; Davis et al., 1989, 1992; Fishbein and Ajzen, 1975; Moore and Benbasat, 1991; Schifter and Ajzen, 1985; Taylor and Todd, 1995; Thompson et al., 1991). For the purpose of this study, the explanatory variables that we retained from the basic model of UTAUT were:

- Performance Expectancy (PE) which is the degree to which a student believes that using Elluminate will help him attain gains in academic performance. This construct was proven to be the strongest (Venkatesh et al., 2003) positive predictor of behavioural intention (AbuShanab et al., 2010; Eckhardt et al., 2009; San Martin and Herrero, 2012).

- Effort Expectancy (EE) is the degree of ease in using Elluminate by students. Elluminate is known to be an easy-to-use and a user-friendly software. As most students in our sample were accustomed to the use of technology thanks to their young age and to their experience with computers, we think that the ease of use of the webinar system will enable a quicker adoption.

- Social Influence (SI) is the degree to which a student perceives that important people, like friends, family members or other students, believe he should use Elluminate. Previous models assessing adoption have shown that SI had a positive relationship with the intention to use a technology (AbuShanab et al., 2010; Eckhardt et al., 2009; San Martin and Herrero, 2012; Venkatesh et al., 2003).

- Facilitating Conditions (FC) is the degree to which a student believes that an organizational and technical structure exists to support the use of Elluminate. The presence of this structure may make most users inclined to adopt the system (AbuShanab et al., 2010; Eckhardt et al., 2009; San Martin and Herrero, 2012).

The dependent variable is the Intention to use Elluminate (IUE). Measuring this construct allows for predicting the acceptance of this technology. Considering the above-cited dependent constructs, we propose to test the following hypotheses:

H_1: Performance expectancy (PE) will affect positively the intention to use Elluminate (IUE).

H_2: Effort expectancy (EE) will affect positively the intention to use Elluminate (IUE).

H_3: Social influence (SI) will affect positively the intention to use Elluminate (IUE).

H_4: Facilitating conditions (FC) will affect positively the intentions to use Elluminate (IUE).

Figure 1 depicts the research model and the hypotheses that we have tested.

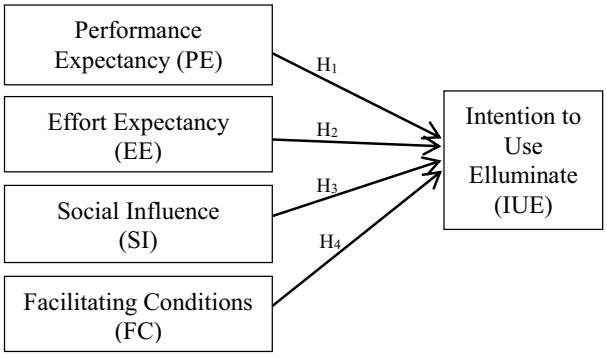


Figure 1. Research model

IV. METHODS AND PROCEDURE

The study sample was made of students enrolled in an undergraduate management information systems course of a business program in Laval University (Quebec, Canada). One of the reasons for choosing this course was that students were using Elluminate and were thus able to inform us about their future adoption of this technology for other courses. Even though we have measured students' intention to use Elluminate at the end of the semester, we think that four months did not made them active adopters of the technology.

The course was a distance-learning course, so all the necessary material was available online. To this material, the teacher added weekly classroom sessions broadcasted live and recorded via Elluminate. The main activities of these sessions were to explain the material available online and to answer students' questions. In this blended learning formula, students had the possibility to follow all the course online, to listen to live sessions without attending the classroom, to

listen to recorded sessions later in the week or the semester, or to combine all these different alternatives. Elluminate was thus an additional "tool" intended to support their learning in the context of an online course.

To collect data, we have used a quantitative methodology based on an online questionnaire containing 27 closed-ended questions (seven-point Likert-type scales from 1 = Strongly disagree to 7 = Strongly agree). We have adapted and translated – to French - the measurement instruments from previous research that have proposed and used the UTAUT model (Venkatesh et al., 2003). For the performance expectancy construct, questions dealt with the role of Elluminate to make learning activities easy, performing, efficient, fast making, and to help guarantee better marks. Effort expectancy was measured with questions about the easiness of the interaction with the system and the competencies and the learning skills needed to use it. Social influence was a more complex construct as it was approached into two ways. First, some questions were about the importance of the opinion of important and influential people when the respondent uses Elluminate. Second, respondents were inquired about the image, prestige, and valorization that the use of Elluminate can bring to them. Facilitating conditions were measured by questions about the availability of human, technological and personal resources to use Elluminate. Two items were added to these questions, one for gender (coded 1 for male and 2 for female) and one for age (a free-entry field). Finally, students were also asked about their major type.

Data collection was made at the end of the semester and lasted five weeks. With a response rate of 35.5%, we have obtained 167 valid responses among the 470 students enrolled to the course. The sample was made of students that have used Elluminate from 0 to 18 times, whether it was live or delayed.

For data analysis, we have used the SPSS software for the descriptive statistics, the measurement of instruments' reliability and validity and hypotheses testing.

V. RESULTS

Descriptive statistics

The sample was mostly made of female students with a proportion of 62.9% (105 female students) against 37.1% for male students. Concerning the age, most students were between 20 and 24 years old (70.1%). 13.8% of the students were younger than 19 and 16.1% were between 25 and 45 years old. Most students were enrolled in thing-oriented programs like accounting, finance, and operation management (53.89% of the sample) and 62 students (37.12% of the sample) were in person-oriented majors such as management, marketing, and management information systems. Thing-oriented refer to majors where courses and learning activities focus essentially on physical objects, numeric data, procedures and sequential representations while person-oriented programs encompass majors where course content and learning activities are centred on people and human relationships (Fallan, 2006). Fourteen students come from unspecified fields.

Reliability and validity

As most measurement instruments were validated by previous studies, we have assessed their validity by means of a confirmatory factor analysis. As we can see in Table 1, all item loadings were > 0.5 as it was recommended by Nunnally (1978), except for three items that were dropped from the facilitating conditions construct. Table 1 made us confident about the reliability of the measurement instruments because the Cronbach Alphas for all constructs were satisfactory (> 0.7 as recommended by Nunnally (1978)).

Table 1. Constructs validity and reliability

Constructs/items	Loadings	Constructs/items	Loadings
Performance Expectancy (PE) *Cronbach alpha = 0.950*		Social Influence (SI) *Cronbach Alpha = 0.848*	
PE1	.814	SI1	.781
PE2	.846	SI2	.797
PE3	.877	SI3	.549
PE4	.926	SI4	.577
PE5	.886	SI5	.765
PE6	.917	SI6	.810
PE7	.904	SI7	.794
PE8	.729		
Effort Expectancy (EE) *Cronbach alpha = 0.905*		Facilitating conditions (FC) *Cronbach Alpha = 0.851*	
EE1	.912	FC1	.933
EE2	.851	FC2	.933
EE3	.885		
EE4	.890		
Intention to Use Elluminate (IUE) *Cronbach Alpha = 0,959*			
	IUE1	.954	
	IUE2	.956	
	IUE3	.974	

Hypotheses testing

Using multiple regression analysis, we have tested the research hypotheses with a stepwise method. As we can see in Table 2, path coefficients were significant for the direct links between the independent variables PE ($\beta = .660$, sig. = .000, $p \leq 0.001$), EE ($\beta = .124$, sig. = .047, $p \leq 0.05$), and SI ($\beta = .265$, sig. = .001, $p \leq 0.001$), and the dependent variable IUE. With these results, hypotheses H_1, H_2 and H_3 were supported confirming the positive links between the three first constructs and the dependent variable.

As it was proven by previous research, performance expectancy was the strongest predictor of the intention to use a technology (Anderson et al., 2006; Khechine et al., 2013; Venkatesh et al., 2003). This result may be different if the study was made in the organizational context. Indeed, students look not only for a better learning, but also and sometimes mostly for an improved performance. This result is strengthened by the young age of the students enrolled in the course whose first concern is often the performance. Indeed, performance could play a major role in their job search and their application for graduate programs.

Effort expectancy affected positively the intention of students to use Elluminate. This result was confirmed by previous studies both in the educational context and in other fields (Torres Maldonado et al., 2011). In the context of our study,

the easiness of use of the system encouraged students to use it. Before adopting Elluminate, students had to use another home-made system that allowed for creating podcasts that can only be listened to after the classroom session. The system was difficult and unfriendly. As noted by Khechine et al. (2010), a lot of students did not adopt the podcasting technology because of many hurdles that they encountered, which was not the case of Elluminate.

Social influence was also a predictor of the intention to use Elluminate. This result was confirmed by other studies in different contexts (Lin and Anol, 2008, Torres Maldonado et al., 2011). To measure social influence, students were asked about prestige and academic development when using Elluminate. The positive effect of social influence on the intention to use Elluminate can be explained by the fact, in a business school, students attach importance to others' opinion. Their image is often based on the criteria of approval by colleagues and teachers.

The fourth hypothesis involving facilitating conditions was not supported. In the context of this study, the technological and organizational infrastructure that supported the use Elluminate was available and easily accessible. Students were provided with an online tutorial, an onsite help desk, and a regularly updated technological infrastructure related to Elluminate. Supportive and knowledgeable staff was working five days a week, not only to answer students' questions quickly, but also to strive to meet their demands. However, business students of the administrative sciences faculty were accustomed with the technological and organizational support. Indeed, they used different technologies and get accustomed to be well supported since the earlier 2000s.

The R^2 value was 0.432, meaning that more than 43.2% of the variance in the intention to use Elluminate construct was explained by the three dependent and significant constructs.

Table 2. Regression coefficients and significance

	Path Coefficient	t-value	Sig.
Intention to Use Elluminate (IUE)		***R^2 = 43.2%***	
PE	0.660	11.290	.000***
EE	0.124	2.000	.047*
SI	0.265	3.453	.001***
FC	0.097	1.582	.116

*** $p \leq .001$ **$p \leq .01$ * $p \leq .05$

VI. Conclusion and Contributions

The aim of this research was to find out the factors than can explain the behavioral intention of students to use Elluminate in an undergraduate course. Results had shown that performance expectancy, effort expectancy and social influence are the three constructs that affected positively the intention to use this system. We think that in a context where the technology affects users' lifestyle and represents an expensive investment, it is important to look for the acceptance of this technology by its users before its adoption.

On the practical side, knowing students' incentives to use webinar will give educators the proper information that would enable them to make informed decisions about adopting such technology. Obtained results could provide higher education administrators and decision makers with research-based guidance about if and how to implement webinar in online academic courses

On the theoretical side, the use of this "innovative" – UTAUT - model represents a great contribution as studies that have used it can be counted of the fingers of one hand. To our knowledge, only two studies applied this model to the webinar concept (Khechine et al., 2013; Lakhal et al., 2013).

VII. References

AbuShanab, E., Pearson, J.M., & Setterstrom, A. (2010). Internet Banking and Customers' Acceptance in Jordan: the Unified Model's Perspective. Communications of the Association for Information Systems, 26(1), 493-524.

Ajzen, I. (1991). The theory of planned behaviour. Organizational Behavior and Human Decision Processes, 50, 179-211.

Allen, I. E., & Seaman, J. (2004). Entering the mainstream: The quality and extent of online education in the United States, 2003 and 2004. Needham, MA: The Sloan Consortium. Retrieved september 20, 2013, from http://sloanconsortium.org/resources/entering_mainstream.pdf.

Anderson, J.E., Schwager, P., & Kerns, R. (2006). The Drivers of Acceptance of Tablet PCs by Faculty in a College of Business. Journal of Information Systems Education, 17(4), 429-440.

Baehr, C. (2012). Incorporating User Appropriation, Media Richness, and Collaborative Knowledge Sharing Into Blended E-Learning Training. IEEE Transactions on Professional Communication, 55(2), 175-184.

Chan, D. (2011). A Comparison of Traditional and Blended Learning in Introductory Principles of Accounting Course. American Journal of Business Education, 4(9), 1-10.

Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: development of a measure and initial test. MIS Quarterly, 19(2), 189-211.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use and user acceptance of information technology. MIS Quarterly, 13(3), 319-339.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: a comparison of two theoretical models. Management Science, 35(8), 982-1003.

Davis, F. D., Bagozzi, R. P., &Warshaw, P. R. (1992). Extrinsic and intrinsic motivation to use computers in the workplace. Journal of Applied Social Psychology, 22(14), 1111-1132.

de Gara, C., & Boora, R. (2006). Using Elluminate as a simple solution for telehealth initiatives for continuing medical education. In T. Reeves & S. Yamashita (Eds.), Proceedings of world conference on e-learning in corporate, government, healthcare, and higher education 2006, 476-480. Chesapeake, VA: AACE.

Eckhardt, A., Laumer, S., & Weitzel, T. (2009). Who Influences Whom? Analyzing Workplace Referents' Social Influence on IT Adoption and Non-adoption. Journal of Information Technology, 24(1), 11-24.

Fabry, D. L. (2012). Using Student Online Course Evaluations to Inform Pedagogy. Journal of Research in Innovative Teaching, 5(1), 45-52.

Fallan, L. (2006). Quality Reform: Personality type, Preferred Learning Style and Majors in a Business School. Quality in Higher Education, 12(2), 193–206.

Fearson, C., Starr, S., & McLaughlin, H. (2012). Blended Learning in Higher Education (HE): Conceptualising Key Strategic Issues Within a Business School. Development and Learning in Organizations, 26(2), 19-22.

Fishbein, M., & Ajzen, I. (1975). Belief, attitude, intention, and behavior: An introduction to theory and research. Reading, MA: Addison-Wesley.

Gosmire, D., Morrison, M., & Van Osdel, J. (2009). Perceptions of interactions in online courses. MERLOT Journal of Online Learning and Teaching, 5(4). 609-617.

Khechine, H., Lakhal, S., Bytha, A., & Pascot, D. (2013, March). Students Acceptance of Elluminate Use in a Blended Learning Course. Proceedings of the 7th International Technology, Education and Development Conference, Valencia. Spain.

Khechine H., Lakhal S., Pascot D. (2010), Pourquoi les étudiants résistent au Podcasting ?, 15e Colloque de l'Association Information et Management (AIM), La Rochelle, France.

Lakhal, S., Khechine, H., Pascot, D. (2013). Student Behavioural Intentions to Use Desktop Video Conferencing in a Distance Course: Integration of Autonomy to the UTAUT Model. Journal of Computing in Higher Education, 25(2), 93-121.

Lin C-.P, & Anol B. (2008). Learning Online Social Support: An Investigation of Network Information Technology Based on UTAUT. Cyberpsychology & Behavior, 11(3), 268-372.

Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. Information Systems Research, 2(3), 192-222.

Myers, M. P., & Schiltz, P. M. (2012). Use of Elluminate in online teaching of statistics in the health sciences. Journal of Research in Innovative Teaching, 5(1), 53-62.

Nunnally, J.C. (1978). Psychometric Theory, New York: McGraw Hill.

San Martin, H., & Herrero, A. (2012). Influence of the User's Psychological Factors on the Online Purchase Intention in Rural Tourism: Integrating Innovativeness to the UTAUT Framework. Tourism Management, 33(2), 341-350.

Schifter, D. B., & Ajzen, I. (1985). Intention, perceived control, and weight loss: an application of the theory of planned behaviour. Journal of Personality and Social Psychology, 49, 842-851.

Schubert-Irastorza, C., & Fabry, D. (2011). Improving student satisfaction with online faculty performance. Journal of Research in Innovative Teaching, 4(1), 168-179.

Skylar, A. A. (2009). A comparison of asynchronous online text-based lectures and synchronous interactive web conferencing lectures. Issues in Teacher Education 18(2), 69-84.

Taylor, S., & Todd, P. A. (1995). Understanding information technology usage: a test of competing models. Information Systems Research, 6(2), 144-176.

Thompson, R., Higgins, C., & Howell, J. (1991). Personal computing: toward a conceptual model of utilization. MIS Quarterly, 15(1), 125-143.

Torres Maldonado U.P., Khan G.F., Moon J., Rho J.J., (2011) E-learning motivation and educational portal acceptance in developing countries, Online Information Review, 35(1), 66 - 85

U.S. Department of Education (2010). Evaluation of evidence-based practices in online learning: A metaanalysis and review of online learning studies. Retrieved september 20, 2013, from http://www2.ed.gov/rschstat/eval/tech/evidence-based-practices/finalreport.pdf

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. MIS Quarterly, 27(3), 425-478.

Wang, S.-K., & Hsu, H.-Y. (2008). Use of the webinar tool to support training: the effects of webinarlearning implementation from trainers' perspective. Journal of Online Interactive Learning, 7(3), 175-194.

Bring Your Own Technology (BYOT) to Education

Joseph M. Woodside, Nasser Alleban, Shahram Amiri
Stetson University
DeLand, FL, USA

ABSTRACT

Businesses are spending increasing amounts of resources on technology devices for employees such as laptops, tablets, phones, computers, printers, scanners and other devices. In an effort to reduce costs and increase worker satisfaction, many businesses have implemented a concept known as Bring Your Own Device (BYOD) or Bring Your Own Technology (BYOT). In one case study Cisco was able to increase productivity by $300 million, eliminate $1.3 million in device spending, and reduce end-user support costs by 25%. BYOD and BYOT is a disruptive force where employees are able to bring their personal devices into the organization and connect (Gartner 2013). Where BYOD typically focuses on smartphone and mobile devices, BYOT expands to all technologies including recent trends in wearable tech. Similarly, many school districts are beginning to implement BYOT policies and programs to improve educational learning opportunities for students who have a wide variety of technology devices (Digital Learning Day 2013). BYOT allow districts with limited budgets enable usage of technology while improving student engagement. (Wong 2011).

When implementing a BYOT strategy, a few of the best practices include development of a formal set of policies including governance, compliance, equitable access to technology, and acceptable usage. The second component includes device management and ensuring compatibility between all devices and development of the appropriate infrastructure to accommodate the increase in demand of traffic and user connectivity. The last area is security, and verifying all devices contain up to date anti-virus software and patches to prevent unauthorized access or loss of data (Gartner 2013, Wong 2011).

One of the latest trends in BYOT is wearable tech such as smart watches and glasses. Shipments of 100 million wearable devices are estimated in 2014, with 485 million by 2018. To further educational learning opportunities these devices must also be incorporated into the classroom and a tremendous area of growth potential within an innovative classroom environment. With BYOT in education, instead of demanding students turn off or put away technology devices, BYOT captures the students use and interest of technology within an educational context (Patel 2013).

Keywords: BYOT, Wearable Tech, Education, Learning Technology

Mathematics teaching practice assessment using student-teacher portfolios

Luckson Kaino
Department of Mathematics Education
College of Education
University of South Africa, Pretoria, South Africa

Abstract

The mathematics student-teacher portfolio is used to document information about mathematics teaching, student-teacher progress through stages of experimentation and achievements during the teacher preparation period. Generally, portfolios have been considered to be reflective tools where student- teachers reflect on why, what and how they teach to meet set objectives. This theoretical paper provides a background on the use of a portfolio in student-teacher teaching practice and its significance in teacher preparation by referring to the mathematics subject. The portfolio assessment procedures are outlined and the portfolio assessment instruments developed and discussed. At the end, the portfolio assessment manual is presented. The author recommends the use of a portfolio in assessing mathematics student-teachers to form a greater part of teaching practice assessment.

Key words: Student-teacher portfolio, Teaching practice, Mathematics teaching, , Assessment

Introduction

The student-teacher portfolio is a process document for the student-teacher development that records progressive levels of achievement in teacher preparation. The portfolio is not a one-time event for assessment but a comprehensive document that records progressive levels of achievement and sets the stage for specific goals. The portfolio applies reflective teaching approaches to professional training and development for student-teacher growth through critical enquiry, analysis, and self-directed evaluation, and has sometimes been distinguished from behavioral skills or craft apprenticeship approaches which, in contrast, emphasized the acquisition of pre-determined classroom practice (Zeichner, 1983; May & Zimpher, 1985). The student teaching portfolios is described as a tool for promoting reflective practice as it provided the opportunity for the prepared teacher to think about what one does and why (Borko, et al 1997) and thus assess past actions, current situations, and intended outcomes, the practice that is reflective rather than routine aiming at helping the teacher candidates to think reflectively on their decisions and experiences (Richert, 1990). The portfolio has been defined as a systematic and organized collection of evidence used to monitor growth of the student's knowledge, skills, and attitudes in a specific subject area (Blake et al., 1995 & Takona, 2003) and also as a purposeful, collaborative, self-reflective collection of student-teacher work generated during the process of instruction (DeBruin-Parecki, et al., 1997). Reflection can influence how the student-teacher grows as a professional by learning from his/her own experiences. Reflective practice has been described to involve one's own experiences in applying knowledge to practice while being coached by professionals in the discipline (Schon, 1996) and introduce the requisite knowledge and skills to approach teaching in a reflective way (Borko, et al., 1997). Research on effective teaching showed that effective practice was linked to inquiry, reflection, and continuous professional growth (Harris, 1998). The latter view seems to hold for over the past two decades now as evidenced from various literature on teacher education. Reflective practice has been found beneficial to professional development at both the pre-service and in-service levels of teaching where student-teachers could improve their effectiveness in the classroom (Ferraro, 2000).

Generally, teaching portfolios have received increasing attention as tools to promote reflection among both experienced and novice teachers and the support for portfolios as reflective tools is strong (Wolf, Whinery & Hagerty, 1995). Proponents of portfolio use claim portfolios provide an opportunity and a structure for teachers to document and describe their teaching; articulate their professional knowledge; and reflect on what, how, and why they teach (e.g., Loughran & Corrigan, 1995; Wolf et al., 1995; Zubizarreta, 1994). Despite some evidences that teacher portfolios were tested tools for assessment many years ago as shown in studies such as those by Athanases (1994) and Wolf et al. (1995), portfolios have seldom been studied as a vehicle for teacher learning and growth. The few published empirical studies of portfolios consistently argue that portfolios appear to foster teacher reflection. At the pre-service level, for example, investigations helped student-teachers to remember classroom events more fully and accurately, and focused their reflections on content and contents of specific aspects of their teaching (Richert, 1990). They also created a need for student teachers to systematically examine their practice; encouraged them to gather information on their practice, their students, and their schools; and created a meaningful context in which to link the university and its research-based knowledge with the classroom and its practical demands (Lichtenstein, Rubin, & Grant, 1992). A study by Loughran and Corrigan (1995) found portfolios to be useful either for encouraging reflection on practice or for helping student teachers in job interviews. Observations indicate developing portfolios during teaching practice enhanced student teachers' interest in teaching practice as it provided the opportunity for student- teachers to reflect on their teaching (Saiqa & Hafiz, 2006).

The portfolio assessment of teaching practice, first introduced at the University of Botswana in 2010, sought to investigate the impact of the innovative new professional development/assessment system on the professional growth and development of in-service teachers in Botswana. The findings of the study suggested that although student-teachers found portfolio development to be cumbersome and time-consuming, the general consensus was that developing portfolios provided useful and valuable learning experience which enhanced their creativity, reflective practice and continuous professional growth (Sithole, 2010). Overall, students found portfolio development and its assessment and evaluation of a cumulative collection of their creative works to be a better approach for the assessment of teaching than the traditional approach. The study also found out that there was a lack of consistency in the way supervisors assessed students' portfolios and for this reason, it concluded with the recommendation that in order to increase the reliability and credibility of portfolio assessment, there was a need to provide intensive orientation and clear guidelines to students and all f supervisors in the form of clear expectations for the purpose of selection of artifacts, organization, reflection, assessment and evaluation of portfolios (Sithole, 2010 ibid.). The findings from the latter study are important towards the adaption of the use of the student- teacher portfolio in assessing teaching practice in the college.

Information that should be contained in a mathematics student-teacher portfolio

The mathematics portfolio records the information on student-teacher improvement and development using the following:

- Establishing and documenting a baseline of information about mathematics teaching
- Progressing through stages of experimentation and change.
- Engaging in collaboration.
- Realizing enhancement of particular areas through rigorous assessment.
- Recording actual improvement and positing further goals.

The student-teacher portfolio should be an evidence based narrative document in which the student organizes details of his/her teaching accomplishments and uses this information of documentation to reflect on teaching experiences for improvement of teaching and student learning. The portfolio supplies the teacher with a vehicle for gathering evidence of learning and for definite action to improve the impact of teaching on a specific student group.

Content of the mathematics student-teacher portfolio

During the teacher training/preparation period, each mathematics student-teacher should generate a portfolio that contains the following information:

- Student-teacher's name: student ID, Year, Subject/Programme
- School name, address, telephone, email, etc
- Name of school supervisor and contacts
- Name of Headmistress/Headmaster and contacts
- Name of class teacher and contacts
- Table of contents: this will indicate what is in the portfolio
- Information sheet about the class (Bio-data of students): names of students, gender, performance in mathematics, etc
- Mathematics syllabus
- Mathematics Teaching Philosophy statement

  The statement may contain the following information:

  i) what the student-teacher believes is good in mathematics teaching
  ii) explanation of what he/she hoped to achieve in mathematics teaching
  iii) description of his/her mathematical teaching strategies and techniques
  iv) mathematics teaching effectiveness and ability of the student-teacher to reflect on his/her teaching and learning

- Records of scheming and mathematics lesson planning
- Records of mathematics lesson notes, assignments, problem-solving activities, tests and other mathematical activities

- Records of evaluation of mathematics lessons by both student teachers and supervisors

- Records of resource materials used: prescribed mathematics textbooks, reference books, calculators, computers, etc.

Summary of what a Teaching Portfolio should contain

As the portfolio is organized in a dynamic assessment task, not simply a static end product, it comprises two important aspects, one is the *process* the other is the *product*. The process involves learning from the variety of experiences offered in the pre-service education program and encouraging student teachers to reflect on these. The *product* is the development of the individual portfolio items that are used to demonstrate this learning to others (Loughran & Corrigan, 1995). The *process* contains:

- Reflection: the student-teacher should be able to reflect on the mathematics topics intended to teach during the teaching practice period as indicated in his/her scheme of work. These topics must have been taught to the student-teacher at pre-service training with micro teaching exercises
- Narrative: the student-teacher should present a comprehensive and clear mathematical lesson plans and notes reflected from the scheme of work
- Analysis: the material in the portfolio should reflect the candidate's ability to analyze the mathematical concepts and examples taught in class, organization and classroom control
- Goals: the goals to be achieved during the teaching practice should be clearly stated and implemented. These should include both the mathematical content and pedagogical knowledge of the student-teacher professional development
- Revisions: the portfolio should indicate revision of mathematical activities by the student-teacher during the teaching practice period. These revisions should indicate the student-teacher ability to reflect on the material taught in class. Also students' mathematical revision exercises should be documented in the portfolio
- Mentoring: the portfolio should reflect the mentorship the student-teacher is going through during the teaching practice exercise as assisted by the school supervisors and visiting mathematics college lecturers
- Improvement: the portfolio should indicate that the student-teacher is gaining knowledge and experience than before the teaching practice exercise commenced

The *product* contains evidence of all the above and should be demonstrated by assessing/evaluating the student-teacher's portfolio and the implementation through the classroom.

Assessment Procedures

First, the teacher and the student need to clearly identify the portfolio contents, which are samples of student work, reflections, teacher observations, and conference records. Second, the teacher should develop evaluation procedures for keeping track of the portfolio contents and for grading the portfolio. Third, the teacher needs a plan for holding portfolio sessions, which are formal and informal meetings in which students review their work and discuss their progress. These sessions encourage reflective teaching and learning and are essential part of the portfolio assessment process (Venn, 2000). According to Paulson, Paulson and Meyer, (1991, p. 63): "Portfolios offer a way of assessing student learning that is different than traditional methods. Portfolio assessment provides the teacher and students an opportunity to observe students in a broader context: taking risks, developing creative solutions, and learning to make judgments about their own performances". Diane Hart defines a portfolio as "a container that holds evidence of an individual's skills, ideas, interests, and accomplishments." The ultimate aim in the use of portfolios is to develop independent, self-directed learners. Long-term portfolios provide a more accurate picture of students' specific achievements and progress and the areas of needed attention (Hart, 1994).

The student-teacher assessment is cumulative and based on multi formative and summative assessment contributing to a single overall grade.

(i) Formative assessment

The student-teacher's formative assessment involves;

- The use of the portfolio information by both the school supervisors/mentors and the lecturers

- Maintaining a currently updated portfolio ready to produce when requested by the supervisors. This includes a continued

reflection and revision on the personal teaching philosophy

- Systematic self-assessments comprising of post lesson evaluations and reports on student-teacher's progress by school mentors/supervisors

Summative Assessment

The student-teacher summative assessment involves;

- Pre and post meeting sessions between the supervisor and student-teacher. These sessions should be used as reflection sessions for planned lesson and taught lesson respectively

- An accumulate mark that would be used with the formative mark generated to develop a final grade

Portfolio Assessment Manual

Score	0	1	2
Item	Nothing provided /no evidence /no resources, etc	Incomplete	Complete/evidence adequate/well articulated, etc
Student-teacher particulars/information			
Table of contents			
Professional knowledge -philosophy of teaching mathematics			
-submitted mathematics lesson plans and written tasks			
Reflection on mathematics teaching & learning			
Mathematics teaching & learning process -schemes of work			
-lesson plans developed from schemes provided			
-resources used-handouts, charts, etc			
-self evaluation of lessons conducted			
-feedback from mentors/supervisors			
-samples of students' work			
Assessing and evaluating students' mathematics work -assessment plan (for a particular topic)			
-an example of assessment given and an example of feedback given to students			
-an example of progressive feedback given to students showing how this was followed through			
-an example of an assessment record sheet			
Management and Organizational skills -description of how a class was organized to carry out a particular mathematical activity and a reflective evaluation of the effectiveness of management skills			
-a record of how the student-teacher dealt with one or two specific discipline problems			
-excerpts from supervisor's reports regarding management and organizational skills			
-description and samples of various forms of mathematics teaching/learning aids used in			

instruction with a reflective evaluation of each resource			
Other professional qualities and developmental plans -evidence of involvement in school mathematics extracurricular activities			
-final reflections on growth and development throughout the course			
Reflections by student-teacher			
Peer assessment of student-teacher's experience during TP based on reflections and portfolio documents			
Interview by mathematics lecturers and department/ministry of education of suitability for another TP or recommendation for employment			

The above manual guide shows that the portfolio construction can be a complex activity that involved set rules and standards (Darling, 2001). The manual should be guided by the nature of the tasks set and the kind of contexts in which student-teachers are prepared (Calderhead, 1989). The assessment manual is flexible and the assessment levels can be set to achieve intended objectives.

Concluding remarks

The importance of using a mathematics portfolio in assessing student-teachers has been articulated and the guide can be formed into a generic manual that can be applied to other subjects. The emphasis is made that portfolios gear to reflective practice in teacher preparation and that in order to promote reflective teaching, a clear conceptual grasp is required of what the processes of reflection in the portfolio involve and what students would usefully reflect about. The student-teacher reflection is influenced by the nature of the mathematical tasks set in the portfolio. The portfolio assessment manual construction is a complex social practice with intentions, rules and standards set to minimize the usual hassles caused by observation of student-teachers during the teaching practices supervision period. The portfolio should not be a one-time event assessment but a comprehensive document that records progressive levels of achievement set to achieve specific goals during the student-teacher preparation period. The student-teacher portfolios should promote students to be reflective mathematics teachers who should link better the theory and classroom practice during all the period of preparation for quality production of teachers.

References

Athanases, S. Z. (1994). Teachers' reports of the effects of preparing portfolios of literacy instruction. *Elementary School Journal, 94*(4): 421–439.

Blake, J., Bachman, J., Frys, M., Holbert, P., Ivan, T., & Sellitto, P. (1995). A portfolio-based assessment model for teachers: Encouraging professional growth. *NASSP Bulletin*, 79 (573): 37-46.

Borko, H., Michalec, P**.,** Timmons, M. & Siddle, J. (1997). Student Teaching Portfolios: A Tool for Promoting Reflective Practice. *Journal of Teacher Education*.

Retrieved on 26.06.2012 from: http://www.questia.com/read/1G1-20295497/student-teaching-portfolios-a-tool-for-promoting.

Calderhead, J. (1989). *Reflective teaching and teacher education.* Teschrn & Teacher Educmon, 5(1). Great Bntam Pergamon Press plc

Darling, L.F.(2001). Portfolio as practice: the narratives of emerging teachers. *Teaching and Teacher Education,* 17: 107-121.

Debruin-Parecki, A., Boaz, M., Shaw, E., Yeager, E., Visscher, S.,& Lehan, M. (1997). Preservice teachers and the development of their self-initiated professional portfolios. Paper presented at the annual meeting of the Michigan Reading Conference, Grand Rapids, MI.

Ferraro, J. M. (2000). Reflective Practice and Professional Development. ERIC Clearinghouse on Teaching and Teacher Education Washington DC. ERIC Digest

Hart, D. (1994). *Authentic Assessment: A Handbook for Educators*. Menlo Park, CA; Addison-Wesley Pub. Co.

Loughran, J. & Corrigan, D. (1995). Teaching portfolios: A strategy for developing learning and teaching in pre-service education. *Teacher and teacher Education*, 11(6): 565-577.

Lichtenstein, G., Rubin, T., & Grant, G.E. (1992). *Teacher portfolios and professional development.* A paper presented at the annual meeting of the American Educational Research association, San Francisco, CA.

May, W. T., & Zimpher, N. L. (1985). *Perceptions of pre-service field supervision: A call for theoretical recognition.* Paper presented at the Annual Meeting of the American Educational Research Association, Chicago.

Richert, A. E. (1990). Teaching students to reflect: A consideration of program structure. Journal of Curriculum Studies, 22,(6), 509-527.

Saiqa. Am& Hafiz M.I. (2006). *Use of Portfolios for Assessing Practice Teaching of Prospective Science Teachers.* International Education Research conference, Adelaide, Australia. Retrieved 15.07.2012 from http://www.aare.edu.au/06pap/aza06731.pdf

Schon, D.A. (1996). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions.* San Francisco: Jossey-Bass, Inc.

Sithole, B. M. (2011). Portfolio Assessment of Teaching Practice: Views From Business Education In-Service Student Teachers in Botswana. *US-China Education Review*, 4, 523-531.

Takona, J. P. (2003). *Portfolio Development for Teacher Candidates.* ERIC Clearinghouse on Assessment and Evaluation. ERIC Digest.

Venn, J. J. (2000). *Assessing students with special needs* (2nd ed.). Upper Saddle River, NJ: Merrill.

Wolf, K., Whinery, B., & Hagerty, P. (1995). Teaching portfolios and portfolio conversations for teacher educators and teachers. *Action in Teacher Education*, 17, (1), 30-39.

Zeichner, K. M. (1983). Alternative paradigms of teacher education. *Journal of Teacher Education*, 34(3): 3-9.

Zubizarreta, J.(1994). Teaching portfolios and the beginning teacher. Phi Delta Kappan, 76(4): 323-326.

Teaching Software Architecture by developing step by step Applications

Charif Mahmoudi
LACL, U-PEC university,
60 rue Charles de Gaulle
9400 Creteil, France
+33643939791
charif.mahmoudi@u-pec.fr

and

Fabrice Mourlin
LACL, U-PEC university,
60 rue Charles de Gaulle
9400 Creteil, France
+33615051551
fabrice.mourlin@u-pec.fr

ABSTRACT
Programming component emphasizes modularity as a key concept. This paper describes our empirical approach of teaching software component architecture in the context of distributed system. We have organized training on this topic for our students at U-PEC University. This course highlights not only property management software but also others non-functional properties such as interoperability, remote access, state persistence or basic security constraints. Each concept is implemented through a joint project covering all lessons. Thus, observation of established properties is evaluated by testing. This training takes place in parallel with management software training on Agile project. All students had to go through the same project phases, produce the same documents based on the same templates, and follow exactly the same process. This study focuses on the project scheduling and how concepts are mapped to project life-cycle. Our results revealed some positive effects for the students who accept learning by experience instead of learning by theoretical approach. Evaluation plays a key role and it is essential to emphasize the role of project realization for a successful approach.

Categories
D.3.3 Programming language, software component, Web development.

General Terms
Design, Composition, Business rules, Experimentation.

Keywords
Distributed system, interoperability.

1. Introduction
Software architecture is becoming one of the most important topics in software engineering. In the past decades software architectures were considered as global design in academic training [1] [2]. This point of view emphasizes design patterns as a key concept and architecture meant client server [3]. With the development of web applications, software architecture has evolved and its description is not limited to a couple of words (client / server). For a new project, the description of the resulting architecture can be expressed in ADL (Architectural Description Language) [4] or Unified Modeling Language (UML) deployment diagram [5]. But the place of this description is more important than before and new development process life-cycle has appeared to answer to this constraint.

When designing any complete degree course there are always a large number of constraints, and normally it is not possible to satisfy all of them. Two of the constraints on software architecture courses are the need to equip the students with the skills they will need in their later careers and to provide them with a broad enough background to be able to evaluate new approaches. Also, we divided the degree course in ten lessons like a scale with ten steps. Each step follows an architecture centric life-cycle.

Such kind of teaching approach has docked a concrete application. This plays the role of auto evaluation for students, and it is a concrete metric for the teachers how the lessons are understood. The planning of both lessons and projects are defined closely. Because Agile methods [6] are used for project management, the concern of sprint and release are used for our academic planning. We have applied a strategy where a lesson is done in a sprint before it is used in the project development. In our context a sprint means two or three weeks depending on the academic holidays.

Our document presents into a first section our training context and the relationships between this degree course and the others. The second section is about the definition of the project, how it is provided to student groups, and the relations with the lessons. The third section is about problems which appeared during the process development. The fourth section is about our results and how an academic year can imply changes into the next one. Finally, we conclude about our teaching approach, its benefits, its drawbacks and the role of the training team.

2. Training context

We present our teaching experience that we have organized for five years in our university (U-PEC, France). The students are registered into a computer science master on a distributed system. Software architecture course belongs to computer science part of the first year of master degree. Also, this knowledge is new to the students. Before this training, the students are the only users of distributed application without any experience on the realization of such system with a so complex architecture.

2.1 What is software architecture

Although the term Software Architecture is widely used, there does not seem to be any clear definition as to exactly what constitutes software architecture. In many contexts, this couple of words are used to express how the application is structured at runtime. It means the set of components, their type, etc.

Moreover, it is not clear whether description languages are aimed more useful for the design of the implementation. We have selected UML because of its simplicity and its readiness for new users. This paper will use the term software architecture description to furnish any component representation during the software development process.

The term software architecture, language will then be used to refer to any language in which it is possible to describe fully the component structure at runtime. This language allows architects to build a snapshot of any distributed execution.

The idea of software architecture is new for students. Also, a language and its precise syntax are a guide to help them towards the writing of a rigorous description. UML and its free editors are powerful enough to provide motivation into this new task.

2.2 Why teaching software architecture

There are a number of advantages in including software architecture as part of the degree course. This is a great tendency for students and to some extent practitioners as well, to think that the most important is graphical user interface. And to know a scripting language is enough to develop everything. The students have no experience on the application of software engineering approach of the whole software development process. Thus, one of the important aspects of software architecture language is that, even for quite simple applications, they force the students to think very carefully about the component structure, and not to get involved in the coding too quickly.

Even for students who have done a lot of programming before even starting on their degree course, the ideas behind software architecture are likely to be completely new, and can provide some motivation for them during early programming courses. Another question appears is the communication between components. Message exchange patterns are also new for them.

Another very important reason for teaching software architecture is that it is considered as key concept into a lot of Web frameworks, and thus students should be familiar with at least the ideas associated with the approach, even if they have not learned a specific Web Framework like Java Server Faces (JSF) or Google Web Toolkit (GWT) that their future job may require.

2.3 When teaching software architecture

Several courses are in close relationships with the software architecture course. First of all, object oriented programming course provides basic knowledge about the structural approach a software project. Java language was chosen by the teaching team because of its simplicity and its robustness for beginners.

Next, the UML course brings a more useful layer approach of distributed software. Then, a sequence of tiers of code is well accepted by the students. Even if the five tiers are given by teachers, this approach is explained through an abstract manner. So, the students admit that a client tier is the resident part which will display the graphical views of the project. Then, the presentation tier is a part of the Graphical User Interface (GUI) of a project itself. Next, the business tier contains all essential rules useful for the project. Next the integration tier represents the front end of the persistence layer. Finally, the resource tier or data tier plays the role of persistence. This layer pattern is the first brick of software architecture.

Finally the software architecture course degree is a prerequisite module for other courses about technical aspects of distributed system such that Web service computing, business process definition, knowledge management, etc. Because these courses are advanced, they belong to the second academic year and it is crucial that software architecture course takes place during the first academic year of the master. The number of sessions needs to place the course during the first semester of the academic year. It is the period where the stress of exams or the anxiety for having internship.

3. Structure of the course

We have decided to promote the software architecture project as a main result of our course. Each session aims to teach a concern useful for the students. Our constraint is to convince students that all the sessions are useful for them to achieve a project solution.

3.1 Project definition

A master project subject is defined for three students and each group has an own subject based on the same scenario. First, there is an authentication step followed by a management of business data. The business domain changes, but not the main strategy. For example, a first subject is on the management of subscriptions for a conference, another is about the management of mathematical formula into a research paper, etc.

3.1.1 Technical constraints

All subjects have the same set of technical constraints. First, the architecture respects the layer pattern, described previously. This means that an end user will use a Web browser as a client tier to demand the GUI. Then, it could use it under security constraints.

Another constraint is about the GUI development. All graphical parts have to be developed with Swing framework and this presentation tier has to respect Model–view–controller (MVC) pattern. This pattern will be implanted and not simply used by the students

Third constraint is about data exchanges between tiers. All communication has to be asynchronous. It involves the use of message queues and a Java Message Service (JMS) broker. This protocol allows a better management of all the tiers of a project without any loss of data.

Because the structure of messages is a key concept, we add another constraint about interoperability between tiers. It means that all messages are written in Extensible Markup Language (*XML*), validated with XML schema. This constraint will force the students to define early in the process development the applicative protocol of their project.

The role of business tier is to receive business data and to apply business rule into a right order. Another constraint is about the rules which have to be externalized. So, it will be easier to evolve the business tier without too many changes.

Last constraint is about integration tier, which manages the persistent layer. We require that all Data Access Object (DAO) will be exposed onto Remote Method Invocation (RMI) protocol. This constraint force to manage several protocols into the project. Also, this involves the creation of RMI server and RMI services. The RMI client has to be developed with respect to independence of knowledge. This means that the RMI client has to load stub before invoking a remote service.

All useful tools and frameworks are furnished by the teaching team because the students are not ready to benchmark several tools themselves. We use mainly apache tools such that (http server, tomcat server, ActiveMQ, Xerces, Xalan, etc.) and MySQL as Database Management System (DBMS) server. Even development tool is given with a right configuration of plug-ins.

3.1.2 Impacts on student group

Because a project is divided into three tiers, each member of a project group has to be responsible of a part (presentation, business or integration). Each student is registered as responsible for the design and the development of a tier. The process development has three increments based on the use case diagram. Each increment corresponds to a meeting with the teaching team and this triggers a valuation of the results.

The first student activity consists in the understanding of the subject and the detection of their difficulties. Different problems occur depending on the experience of the students. Also, they have to sort the risks of the project and eventually, they can add ranks. This exercise allows the students to understand that they share the same kind of problems. But they have to adapt their knowledge to their own project.

Secondly, because each part sends and receives data, each couple of students have to define an XML schema for the applicative protocol between two tiers: presentation and business and business and integration. So, they have a precise objective to achieve and also the need of a teaching session about XML and schema.

3.2 Session scheduling

Courses are taught in sessions of 180 minutes. This course is taught for ten sessions, totaling 30 hours. Each session has a precise subject in close relation with the needs of students for their project. It is divided into two parts. The first one is a theoretical approach of the subject and the second part is a direct application of computer.

The first session covers the use of XML language and how to define an XML schema with the objective to define the message structure into a distributed system. The application is about transformation of XML streams into Java objects and the reverse.

The second session is about component diagram with UML language. The objective is to define vocabulary such as component, component server, artifact, bundle, etc. The exercise is the build of Java archive and its loading during the runtime of an application. We highlight that jar file can be the format of a deliverable.

The subject of the third session is MVC pattern. We show that architecture pattern leads the structure of the presentation tier. It triggers class definition with name convention. We present a web framework based on this pattern such as JSF. So, we developed another implementation (written in Java) of this pattern for the display of data model into two frames.

The subject of the fourth session is about asynchronous communication into a distributed system, its benefits such that independence component, persistence of the message, etc. Also, a JMS broker is described as a mediation tool which introduces a fault tolerance skill. We show through an exercise that this ability allows updating a part of distributed software during runtime.

The fifth session is about http protocol and how to use it as transport protocol. It is a vehicle to trigger the business part. Development frameworks provide a technique to handle a session. So, the applicative part is on the development of a web-application using tomcat server with resource access through Java Naming Directory Interface (JNDI) bindings.

The externalization of business rules is the subject of the sixth session. More precisely, we propose to write business rules into a functional language called XSLT (Extensible Stylesheet Language Transformations). We explain the inference rules Apache Xalan, its choice of rules. The exercise is about the transformation of an XML stream into another. Input XML is computed by a deserializer from a Java object. Also, a pipeline of transformations can be considered as a sequence of business rules.

Remote invocation is a key concept into a distributed system. This is the subject of the seventh session. We insist on the difference between the server and service, the role of a registry and especially on the construction of a correct RMI client. It does not know the implementation of the service and only remote interface. Also, a right implementation downloads an archive which contains the stubs of the remote service. The application is a prototype of a service which allows users to read system resource. Next we develop a client which requests a particular resource name.

The eighth session is about the separation of concern in object oriented programming. The integration tier has access to DBMS via Java DataBase Connectivity (JDBC) driver. This session explains that a class cannot belong to several components and that it is wrong that a class can be copied into several components. Very often this situation corresponds to a misunderstanding of the class concept. One class represents one concept and nothing more. Also the application is an extraction of data (instance of Todo class) from a database and transfers it to a client. Two classes Todo exist in separate packages. The first one is for the data extraction; the second is for the data transfer object.

The ninth session is about security concept and the definition of login module. This session shows that the security is not closed for an application server, but is an autonomous handler. It has the responsibility of checking user information onto several servers and finally it accepts or not the user connection. Any change into the authentication strategy does not affect the business part of the whole application. The application is a development of a login module with Java Authentication and Authorization Specification (JAAS) framework.

The last session is about distributed transaction and the ability into distributed software to manage set of statements. This session shows that the transaction concept, which comes from the database, can be moved into the integration tier which is in front of it. So, it can play a role of cache. So, this can prevent application stress when the amount of request increases dangerously. The exercise is the management of a set of commands in an ACID (Atomicity, Consistency, Isolation, and Durability) transaction. Spring Framework is used as a Java Transaction Service (JTS) implementation.

4. Process development

The chronology of sessions related to the Agile development steps of a software component. The transverse sessions to three third of the layered architecture are being taught first. Then, specific sessions to each third are taught. Given the incremental and iterative development process adopted for the project, students do not need of mastering all the technologies and principles first; they must master just a minimum which will allow them to address the current phase of the incremental cycle.

4.1 Project phases

As shown in Figure 1, the Agile incremental cycle consists of four phases spread over the academic year.

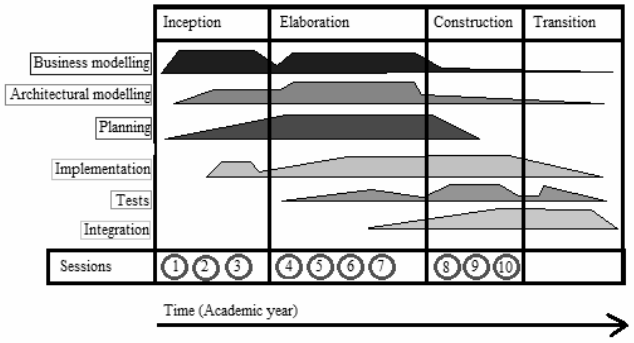


Figure 1 Incremental cycle

4.1.1 Inception

During this phase, the student must formalize a vision of the product. This vision contains five essential parts:

- A simplified use cases model involving the main use cases
- A preliminary architecture in a draft within the major subsystems
- A detailed Planning of the elaboration phase
- An estimate of the overall project
- Identification and prioritization of key risks

This first phase shall run working closely with the teaching staff. The three student members of each group collaborate to implement and specify a fist technical User Story such as authentication. This allows each group to address issues of "communication and integration" transverse to the product.

The sessions provided during this phase are the first, second and third session. The goal is that students can familiarize themselves with the architectural models and modeling languages. This initial use serves to anticipating potential design problems that students might encounter during the next phase.

4.1.2 Elaboration

This phase allows students to specify most of the use cases and design the system architecture. It allows the student to be able to plan activities and estimating skills and the time required to complete the project. This phase allows the emergence of the following parts:

- Stable use cases
- A reference architecture
- A detailed development plan
- Risk management to ensure compliance with the project statement

During this second phase, the students are being pushed to be independent. At this stage, they acquired the necessary skills to define the architecture and a high level model of the project; they must provide a more detailed level. In parallel with this, the sessions on the interoperability are ensured. These sessions are : four, five, six and seven. The goal is to familiarize students with the technologies they have to specify in their models during the current phase and give them time to assimilate in order to use them in the next phase.

4.1.3 Construction

This phase is dedicated to the construction of the product; it comes to transform the model into a concrete product. This product covers the scope defined for the current increment. The presence of defects at this level is not shocking; the next level is intended to their resolutions. In parallel with this phase, specific sessions to different component are provided. This relates to sessions, eight, nine and ten that address the specific mechanisms to data access, security, and transactions.

4.1.4 Transition

This last phase is intended for testing corrections and optimizations of the application. Demonstrations in the steering committees are used to identify any functional or conceptual anomalies. This phase involves the integration between the various components developed by each student in each group.

4.2 Project cycles

As the project unfolds over three cycles; each cycle ends with the delivery of a new increment (system version). This product consists of the source code components that have been created or updated. Each delivery is accompanied by documentary deliverables as shown in Table 1. Different models to produce documentaries for the activities are detailed in Section 5.

Model	Description

Use case model	Outlines the use cases identified from the project statement
Design model	Defines the static structure of the system as classes and sub-system for each tier. It defines the use cases implemented as collaborations between the group subsystems
Architecture model	Architecture description
Implementation model	Integrate components as source code as well as the mapping between classes and components
Test model	Describes the test cases checking out the use cases
Deployment model	Defines the physical structure of the components of the nodes (virtual machines) dedicated to the group, it highlights the allocation of these components on these nodes.

Table 1 Deliverables models

5. Results

We have organized three appointments were each three student group makes a presentation, followed by an exhibition and a meeting with teaching team. This allows teachers to evaluate the students, their contribution to the project. Also, it is a time where students can expose their own difficulties not only technical but also functional. Some problems are also about collaborative exchanges. The evaluators provide by the end of the meeting a textual summary of the working session and explanation about it.

For each appointment, the student group has to provide deliverables: source code project, test suite reports, project tracking report and Agile diagrams. All these documents are used during the working session.

5.1 Project presentation

Each project has a 30 minutes presentation. It means ten minutes per student. He displays information on his project tier and use specific presentation to highlight his contribution, his difficulties and also, his solutions.

Often, it is not easy for a student to accept that he will be evaluated only on a part of the whole project. This could be seemed unfair, whether the content of his part was judged smaller by the evaluator. Also the frontiers of student talks are not so clear and questions are necessary to clarify the student roles in the group. Next, questions are asked by the evaluators and this is tests to understand in depth the knowledge of students. For instance, after explaining the communication XML schema between his tier and the next tier, there are questions about the definition of complex types and elements which are in the XML schema. A kind of question is: what are the differences between exchanges of business data instead of exchanges of command about them. Each talk ends with remarks on the project roadmap and how the work was managed over the sprints. Sometimes, tasks are delayed until the next release or bad estimation of time involves a split of a task into several ones. Finally, the new release map is presented and validated by the evaluators.

The respect of scheduling is crucial because these students have other courses and a 10 minutes delay at the beginning of the session can mean more than one hour by the end of the session.

5.2 Project exhibition

The test report describes the test suites and the results for each tier and for the whole application. The student group has 30 minutes to make an exhibition of a business use case. The business scenario is chosen by the students and all technical aspects have to be present and observable. The useful laptops are installed and configured by the students and any incident has to be explained to the evaluators.

Often a whole tier is missing and students developed a fake to simulate a simple behavior. Another problem could be the use of a tool which is not validated by the teacher team. More complex errors occur when the students do not understand distributed aspects of their project. For instance, only one client can send a request to a business tier. The second request has to wait for the reception of the first answer by the first client. This needs additional remarks from the evaluators. This, also shows that the test plan is not correct and it could be improved with another new test suites.

Finally, there is code audit. It means that students have to display their code with the beamer and they have to explain into details their technical choices (design pattern, separation of concerns, best practices, etc.). It is interesting to know how student judge their own code. Often, there is no metric at all and the answer is totally empirical. They do not have the need to define a criterion or to propose a tool to compute observations. Recommendations are made by the evaluators which will be written into the final summary.

5.3 Project evaluation

During this academic year, we were two teachers for this software architecture module. Also, we were the evaluators for all the groups. Each appointment gives rise to evaluate each student through three facets: his own work, his work in the student group and his behavior during the appointment. This means three scores per student per appointment. These help us to provide a final score for the module.

Because we assist all the students, it becomes easy to detect cheating. Students who don't do their own work put honest students at a disadvantage. Every student deserves the chance to show what they have learned. Our objective is to give honest students an equal opportunity to demonstrate their own academic achievement on a fair and equal playing field.

The progress of the project is also a right metric to guess the understanding of students with the new concepts of software architecture. At the last appointment, they should have to demonstrate a complete component approach with hot component deployment, asynchronous communication and externalized business rules. So, improvement can be observed.

6. Conclusion

After several experiences, we related in this paper our strategy to teach software architecture and more precisely how to model the physical aspect of an Object-Oriented software system. We use a strategy based on couple of approaches: a theoretical one and a

pragmatic one. We have demonstrated that a step by step experiment is a practical guide to understand abstract concepts like component, interoperability or asynchronous exchange.

Another consequence of our approach during the first year master degree is the increase the success rate in the second year master degree. Because the main architecture concerns are better understood, the students have a better experience to succeed the new academic year.

7. REFERENCES

[1] J.F. Naveda: Teaching architectural design in an undergraduate software engineering curriculum. In: 29th Annual Frontiers in Education Conference (FIE '99). Vol. 2, pp. 12B1/1- 12B1/4 (1999).

[2] A.I. Wang and T. Stålhane : "Using post mortem analysis to evaluate software architecture student projects," Software Engineering Education Conference, Proceedings, Dept. of Computer and Information Science, Norwegian University of Science and Technology, Sem Sælandsv. 7-9, NO-7491 Trondheim, Norway: 2005, pp. 43–50.

[3] A. G. J. Jansen and J. Bosch : Software architecture as a set of architectural design decisions. In Proceedings of WICSA 5 , Nov. 2005, pp. 109–119

[4] D. Garlan, R. T. Monroe and D. Wile: Acme : An Architecture Description Interchange Language. In: Proceedings of CASCON'97, 1997

[5] J. Rumbaugh, I. Jacobson and G. Booch : Unified Modeling Language Reference Manual, 2nd Ed. Pearson Higher Education, 2004.

[6] D. F. Rico and H. H. Sayani: Use of Agile Methods in Software Engineering Education, in Agile, 2009. AGILE'09. Conf. IEEE, 2009, pp. 174–179.

Which Virtual Classroom Tools Are Used in the Distance Education?

Duygu Mutlu-Bayraktar
Istanbul University Department of Computer Education and Instructional Technology

Istanbul, Turkey dmutlu@istanbul.edu.tr

Abstract—There are some limitations in terms of communication type and interaction in Distance Learning Environments according to face to face environments. In despite of these limitations, online environments provide easiness of communication in terms of time and space. Many higher education institutions make investments to use distance education as training purpose and develop web-based training programs. In addition, companies adopt web-based training systems to educate increasing number of employees. In despite of extensive usage, many criticisms about Distance Learning Environments are about missing experiences, discussions and social interactions during courses. Synchronous virtual classes which decrease considerably these criticisms are used in online training environments. Virtual class tools provide instant reciprocal video, sound and data communication between two or more people. In this study, Adobe Acrobat Connect Pro as part of Istanbul University Distance Learning and 14-week virtual class lecture records of 3 courses given by instructors in Computer and Instructional Technologies Education Department were investigated. The aim was to determine which virtual class tools instructors used and how often they used the tools during lectures by means of content analysis. It was seen that instructors used mostly presentation and chat tools. In addition to that, a survey was applied to 40 students taking lectures from virtual class environment. The survey was applied in virtual class environment with use of survey tool and the results were obtained with the same tool. According to the survey results, the students find video sharing more interesting than presentation tool in lectures. The students find sharing of instructor self-computer screen more effective than presentation. Also, the students find use of whiteboard more effective in terms of understandable lectures.

Key Words—Synchronous Learning, Virtual Classroom Tools, Web Based Distance Education

I. Introduction

Virtual classroom is an educational approach by which the education is performed independently from time and place; the computer is used as an education, presentation and communication tool and which is performed in two different ways as synchronous and asynchronous according to the fact that whether teachers and students interact to each other in the same place and same time (Karaağaçlı, 2004).

Synchronous Virtual class tools are online learning tools which are able to provide synchronous vision, sound and data communication interactively between users on online media. From this aspect, synchronous virtual class tools, as well as providing multi-directional communication opportunities to learners, also provides a collaborative environment in which students can study together so that they can decrease the critiques against the distance education systems (Schullo, et al., 2007).

It is known that virtual education will form a considerable part of education activities in future, especially of extend of lifelong learning. In spite of this, as in all new applications, the application results should be evaluated. When problems arising due to categorization of problems faced in virtual training environments are analyzed, it is seen that ineffective use of the environments by instructors are one of the problems (Jones, 2005). Instructors should use the tools more efficient for virtual training environments to be student-centered and used effectively.

As in formal education, an important management plays a critical role in achieving education goals in virtual class applications as part of distance education. Technological excitement can result in innovations which are not well-planned and this can cause to face with some problems in performing training goals prognosticatively (Erden, 2003). It is quite important to use the tools provided by education technologies effectively and appropriately to prevent this situation.

All opportunities provided to students and educators by learning management systems occur due to the tool that they have (content tools, communication tools, evaluation tools, student tools, management tools, equipment and software tools). The features that a good learning management system should have are consequently determined by considering these tools. The effective use of these tools provides training environments having high success level (Paulsen, 2003).

Pullen (2010) examined the virtual class tools of his own institute and focused on technological base and classroom organizations needed to achieve a successful synchronous education on Internet. He gave information generally about multimedia application and network connections.

In the study carried out by Suanpang, Petocz and Kalceff (2004), it was revealed that educations with efficient use of online environments were more effective than traditional education in terms of cognitive skills, value and easiness. On the other hand, in the study carried out to determine the effects of virtual training environments on student success and behaviors by Atıcı (2004), they found that virtual training developed further and different aspects desired and determined by emphasizing the importance of communication extent in training environments (instructor-student, student-student).

In a study that compared traditional class and virtual class education processes, the education process was evaluated by

Duygu Mutlu-Bayraktar, Author is with Istanbul University, Department of Computer Education and Instructional Technology, Istanbul, TURKEY (Address: Muskule Sok. No:1 Vefa Istanbul University Fatih Istanbul Turkey, 34116, e-mail: dmutlu@istanbul.edu.tr, Telephone: +90555 765 57 17).

dealing with the out-class activities of education, assessment and evaluation. It was concluded that virtual class education method by online loaded tools used was more effective than the traditional education method (Annagylyjov, 2006).

In one of virtual class examples, digital notes written on electronic board with synchronized audio and video records of instructor can be presented as online on cameras in McGill University, Canada. The design and development of virtual classes in McGill University begun in 1999 fall term and they are used as virtual classes that are closest to face to face education (Starke-Meyerring & Andrews, 2006).

In our study, virtual classrooms prepared by Adobe Acrobat Connect Pro software were examined. Adobe Acrobat Connect Program is a 'Fast Education Development' platform on which live, interactive web meetings, virtual classes, courses can be arranged; by which related reports can be prepared about all activities and indexes; by which presentations can be compared by students on the basis of curriculum. As well as audio and visual communication, one can share flash animations (.swf), software simulations, visual elements, video files (.flv) and desktop; can perform texting and illustrated instruction by white board.

II. PURPOSE OF THE STUDY

The aim of this study is to determine the virtual class tools which are being used, in the content of university, by instructors of Computer Education and Instructional Technology Department in virtual classes with the goal of distance education and to analyze views of the students about these tools. It is also aimed to determine and discuss that which tools are being utilized in which lessons by the instructors and which tools are being preferred by students.

Questions of the Study

1. Which tools are used in virtual classroom environments?

2. What are the students' views of the tools used in respect of the courses?

III. METHOD

The model of the study is survey method. The descriptive survey tries to describe and explain what are the events, objects, beings, institutions, groups and many fields (Karasar 1999). This method has been used to determine which tools are used in virtual classrooms and to find out about the views of the students' of virtual classroom tools who take these courses. For this purpose, an analysis of virtual classroom lesson videos that was conducted by Computer Education and Instructional Technology Department in 2010-2011 academic year within the scope of distance education has been done.

The reason of why these courses were chosen is that Turkish, Written Expression, Principles of Kemal Atatürk and Foreign Language courses are given to the whole university commonly. Major area course Information Technology in Education, education course Introduction to Education, one of the general courses Calculus, which are outside these courses, have been chosen. How often, within the instruction process of 14 weeks, the instructors of these chosen courses used which tools in virtual classroom environments have been studied. For this aim, Information Technology in Education, Calculus and Introduction to Education courses, which are offered to Computer Education and Instructional Technology Department, have been studied, the Synchronous Virtual Class Tools and their frequency levels have been determined, the students' view about the usage of these tools have been asked for and the contributions of the tools have been discussed. A questionnaire that had been formed by the researcher has been administered to get the students' views about the tools used.

A. Participants

In this study, the questionnaire has been administered in virtual classroom lesson environment and filled in by the 40 students who attended virtual classroom course taking part in the lesson.

B. Data Collection Tools

Within the scope of the study, to determine the virtual classroom tools that the instructors use, every lesson video has been recorded on Adobe Connection virtual classroom for a term every week. These videos that had been recorded have been analyzed by controlling on a checklist prepared.

A questionnaire that had been formed by the researcher has been administered to get the students' views about the tools used. The questionnaire has been administered in virtual classroom lesson environment and filled in by the students taking part in the lesson. The questionnaire results were calculated in Adobe Connect program.

C. Data Analysis

The course videos that had been recorded have been analyzed by controlling on a checklist prepared. Survey data was gathered via Adobe Connect program and percent frequency results were obtained from same program.

IV. FINDINGS

The findings and comments obtained from the study will be touched upon in this part. At the end of analyses of 14 weeks virtual classroom environments of Information Technology in Education, Calculus and Introduction to Education courses, which have been dealt with within the scope of the study, it has been seen that the most frequently used tools are presentation sharing and instant chat (See Table 1,2,3).

It is seen that the tools used show variety according to the lessons. In Information Technology in Education course, it is seen that the instructor often uses tools such as questionnaire, sharing his or her own screen and note writing. In Introduction to Education course, which is more verbal, it is observed that it is covered with presentation more and not many tools are used. However, in Calculus course, it is seen that, differing from other lessons, a marker is used and marks and drawings are made on the presentations with the marker.

When looked at the questionnaire results, in respect of the tools used:

- The question "In information major courses (Information Technologies in Education, Programming etc.) which of the tools used help you more to teach the lesson better?" was asked and the students' views were taken. Table 1 shows the questionnaire results that were obtained in Adobe Connect program. According to these results, it is seen that 65 % of the students find the instructor's sharing his or her own screen more effective. While presentation is seen as a second effective tool with 22,5 %, sharing the lecture notes is seen the least effective with 12,5 %.

Items	f	%
Presentation	9	22,5
Instructor's sharing his or her own screen	26	65
Using the lecture notes	5	12,5

Table 1: The tools preferred to be used in informatics courses

- By asking the question "Which tools do you want to be used in education courses to make course more interesting?" the students' view about the tools used in education major courses were taken. A 47,2 % portion of the students preferred video sharing in the lesson to make the lesson more interesting. Using presentation tool, however, seems to be the choice of 33,3 % with a close percentage. They found the student involvement in the lesson by an audio way less interesting with a percentage of 19,5 % (See Table 2).

Items	f	%
Presentation	12	33,3
Video sharing	17	47,2
Involving the student in the lesson by audio-visual way	7	19,5

Table 2: The tools were preferred to be used in education courses

The question "Which tools do you want to be used in Calculus course to make the course more understandable?" was asked and the students' views about the courses that require more calculations were taken. 82% of the students seem to prefer the use of whiteboard tool in this lesson to make the course more understandable (See Table 3). Using presentations and students' participation in the lesson in an audio way follow the white board tool in close percentage points.

Items	f	%
Presentation	4	10,25
White Board	32	82,05
Involving the student as audio-visual in the lesson	3	7,69

Table 3: The tools were preferred to be used in calculus courses

- The students' views as to the tool they find most effective in communication have been taken by asking the question "Which tool can you use more comfortably to communicate your ideas in the lessons?". A 71,05 % majority of the students have stated that they can communicate their ideas most comfortably in chat area. A 26,3 % group of students, however, have stated that they can use the questionnaire tool comfortably in communicating their ideas. Involving in the lesson in a verbal way, however, seems as a tool, with a low percentage of 2,65 %, in the results that is not used a lot (See Table 4).

Items	f	%
Instant Chat	27	71,05
Questionnaire	10	26,3
Involving in the lesson in an audio way	1	2,65

Table 4: The number and frequency distribution of the question "Which tool do you use more comfortably to communicate your ideas?"

- For the question of "What things can be done to make the lessons more student centered?" the students answered the choices of loud lecturing and sharing students' screen with close percentage points. Moreover, using these two tools, it is thought, will make the lesson more student centered.

Items	f	%
Involving in the lesson in an audio way and lecturing	23	51,11
Sharing students' screen	22	48,89

Table 5: The tools that would provide the lectures to be student-centered

A. Usage Situations of Virtual Classroom Tools

Presentation: Presentation sharing tool, which is the most frequent used tool, has been used in every lesson. This tool, which instructor use as an aid to themselves while lecturing and as a support to the students' visual learning, is an important tool in virtual learning applications.

When looked at the questionnaire results about presentation tool, it is seen that, in education courses, they prefer the course being taught on presentation (%33,3, See Table 2).

Instant Chat: It is seen that the chat tool, which an

instructor uses in every lesson to communicate with the students, is used in all courses. It is seen that it is the most used tool and that they use it when communicate at the times when students cannot do audio involvement.

When looked at the questionnaire results, it is seen that students prefer chat environment as a way of most comfortably expressing their ideas (%64, See Table 4). This area, where they can communicate instantly and rapidly, is one of the effective communication tools used in virtual classroom environment.

Involving the student in the lesson by audio-visual way: In all of the lessons in the first weeks, the instructors involved the students in the lesson loudly in order to get to know the students and to introduce this tool. In this way students are stated that part from chatting they can involve in the lesson loudly. However, according to the questionnaire results, it is seen that students do not prefer much the choices of audio-visual involvement as a way of expressing their ideas (%2,65, See Table 4).

Note Writing: The note writing tool, which is observed to be used frequently in Information Technology in Education course, includes the notes that he or she has shared about the topics they want to communicate in other courses as well (Figure 1). Especially in examination terms, it is observed that the instructor displays the notes he or she wants to announce with note writing tool on the screen.

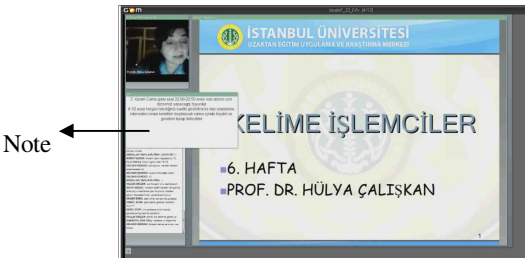


Figure 1. Screen shot of Note Sharing

Making Questionnaire: It is seen that this tool, which is observed to be used only in Information Technology in Education course, is used only for such purposes as taking students' views and getting information during the lesson (See Table 1, Figure 2). According to the questionnaire results, students stated the questionnaire tool as the second best tool in communication their ideas after chatting (%26,3, See Table 4).

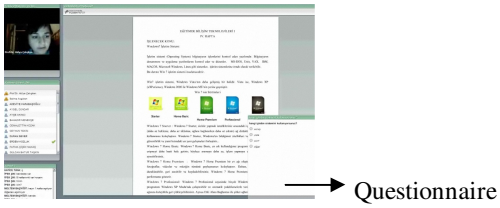


Figure 2: Questionnaire Screen shot

Sharing questionnaire results: The instructors can share the questionnaire results on the screen (See Figure 3). This tool, like questionnaire application, has only been used in Information Technology in Education course.

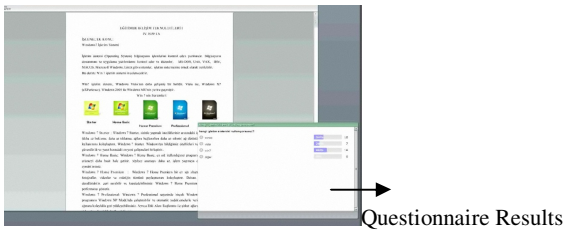


Figure 3: Screen shot of Questionnaire Results

White Board: In the courses analyzed, it is seen that the white board application has been used only once in Information Technology in Education course. In respect of the courses, especially in Calculus course, the use of this tool is very important. It is considered that showing the calculations and solutions to be done about the topics on the white board will be more effective for calculation following, sequencing and lecturing. The answers that the students have given in the questionnaire have a nature to support this result. The students have stated that using white board in the lessons which require a calculation such as Calculus is the most effective tool (%82,05, See Table 3).

Paper Presentation: In distance education, a paper document is being prepared as a support to the students' studies for every lesson. The paper documents that have been prepared for this purpose can be used for this aim. In all the courses analyzed, it is seen that paper presentation application is only used in Information Technology in Education course.

Using a Marker on the Screen: This tool, which is used to do marking on the presentations, has been used only in Calculus course (See Figure 4). However, in the lesson it is seen that it is used to do calculations, to underline and to emphasize.

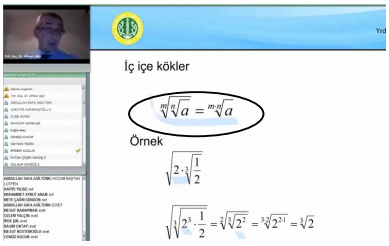


Figure 4: Screen shot where a marker is used

V. DISCUSSION

Learning frames have to be formed in web based virtual classrooms in which a student can explore the knowledge freely, and where they can communicate with each other and with the instructor comfortably. By providing such facilities, a student can be activated in class by forming a more constructivist environment. The virtual classroom tools that

can be used for this aim will contribute to the lessons conducted in the web environment to be more student centered.

The main learning theories are objectivism and constructivism. Objectivism, being teacher centered, is a theory of learning where knowledge is transferred from teacher to student, and where objectives are set by the teacher. They are learning environments where students are involved as more passive learners. As opposed to objectivism, constructivism is a learner-centered theory of learning. Students obtain the knowledge by exploring it for themselves. In this process a teacher, by guiding them, assist the learners in constructing their own knowledge (Jonassen, 1991; Cronjé, 2006). It is observed that web based learning environments are usually carried out in accordance with the tools that demonstrate an objectivist approach These environments, by use of new developments in technology, provide students' being active by making more constructivist.

Dessoff (2009) points out that instructors having formal class experience cannot be always equally successful in both online and virtual education. It is also emphasized that mentioned communication skills have a great influence in increasing the student motivation and creating a comfortable class environment by using technological tools.

Presentation and chat, which are the most frequently used virtual classroom tools which are dealt with in this study, helps the student in gathering information and interacting. In addition to these, a student can directly involve in the lesson in an audio – visual way. At the same time, with the permission of the instructor, a student can do a calculation by using a marker, can prepare and share a presentation or can do and present a study with other classmates in the lesson. This type of studies enables both an interaction in virtual classroom and student's being active. Thus, education can be enriched with various methods in an individual and collaborative way (Lukosch, 2007).

It is seen that the virtual classroom lesson environments that have been analyzed with the scope of this study are more objectivist environments. The lesson progresses under instructor's control. The lesson usually progresses in the way of presentation. Some tools such as presentation, sharing own screen, and white board are auxiliary tools that an instructor can use while they are presenting the lesson. Besides the instructor's using these tools to lecture, different methods can be used by allowing the student to use.

In the virtual class application developed by Glava and Glava (2011), they present an environment supporting individual and collaborative training in addition to providing opportunity for learners to rise their skills to higher levels with effective use of the tools. Thus, it provides effective education period for both lecturer and learner.

In virtual classroom environments, it is recommended that students participate in the lesson with interaction tools and the instructor provide their active participation by using different methods. Especially, the tasks given, the questions directed at the student and the methods used increase the involvement of the students. In addition to these, using interactive activities, videos, animations and simulations in class will make the lessons more effective.

As a result of the courses' being different major courses, it is seen that there are differences in respect of the tools used. It is seen that Information Technology in Education course is richer

In terms of using tools and Introduction to Education course, however, is weaker. Information Technology in Education course has been a rather rich course in terms of using tools since it requires different tools such as sharing the instructor's own screen in the topics about computer programming and operating systems. Also, the instructor's being a staff member of Computer Education and Instructional Technology Department shows a difference in using different tools and in encouraging the students about this subject. However, in Introduction to Education course, since it is a more verbal course, different tools have not been used by usually progressing with presentations. In Calculus course however while it has to be rich in terms of using tools it is observed that it usually progresses on presentations.

At the end of this study conducted, the tools used in virtual classroom environments, while taking the instructor to the center, put the students in the position of listeners and watchers. Also, it is seen that the instructors' tendency to the technology and the structure of the course content effect the variety of tools used

As a result, it can be emphasized that the tools used or developed in virtual classroom environments should be more student centered and instructors need to be encouraged to use these tools more. It is recommended that in-service training be carried out for this aim.

In the light of this study, further studies for development of more student-centered virtual class environments can be carried out. Besides communication tools used in virtual class environments, a study about evaluation tools can be suggested to be carried out. In addition to these, a study investigating training approach and strategies used by instructors in virtual environment can be performed.

REFERENCES

[1] Anderson, T. "Teaching in an online learning context. In T. Anderson & F. Elloumi (Eds.)", *Theory and practice of online learning,* 271–294, Athabasca University, 2004.

[2] Annagylyjov, Y. "Geleneksel öğretim ile sanal sınıf öğretim süreçlerinin öğrenci başarısına etkisinin karşılaştırılması", Unpublished Phd Thesis, Gazi University, Ankara, 2006.

[3] Cronjé, J. C. "Paradigms regained – towards integrating objectivism and constructivism in instructional design and the learning sciences", *Educational Technology Research and Development*, 54(4), 387-416, 2006.

[4] Dessoff, A. "The rise of virtual teacher.", *District Administration*, February 2009.

[5] Erden, A. "Sanal okul.", *Bilim ve Aklın Işığında Eğitim Dergisi*, 4(40). 2003.

[6] Jonassen, D. H. "Objectivism versus constructivism: Do we need a new philosophical paradigm?", *Educational Technology: Research and Development*, 39(3), 1991.

[7] Jones, D. "Computing by distance education: problems and solutions", Integrating Technology into Computer Science Education, Association for Computing Machinery, Barcelona, Gordon Davies, 139-146, 2005.

[8] Glava, C. C. & Glava, A. E. "On-line learning platforms as virtual classrooms. Case study of initial primary teachers training at Babes-Bolyai University of Cluj-Napoca, Romania." *Procedia Computer Science*, 3, 672–676, 2011.

[9] Karaağaçlı, M. *Eğitimde Teknoloji ve Materyal*. Pelikan Yayıncılık, Ankara, Turkey, 2004.
[10] Karasar, N. *Bilimsel Araştırma Yöntemi*, 9. Basım, Nobel Yayın Dagıtım, Ankara, 1999.
[11] Lukosch, S. "Faciliating Shared Knowledge Construction in Collaborative Learning", *Informatica*. (31), 167-174, 2007.
[12] Paulsen, M. F. *Online Education: Learning Management Systems*. NKI Forglaget, Norway, 2003.
[13] Pullen, J. M. *Synchronous internet distance education: Wave of the future or wishful thinking?* In J. Lohmann & M. Corradini (Eds.), e-Technologies in engineering education: Learning outcomes providing future possibilities. Access from Proceedings of the eTEE Conference, 2004.
[14] Schullo, S., Hilbelink, A., Venable, M., & Barron, A. "Selecting a virtual classroom: Elluminate Live and Macromedia Breeze (Adobe Acrobat Connect Professional).", *MERLOT Journal of Online Learning and Teaching*, 3(4), 331-345, 2007.
[15] Siemens, G., & Tittenberger, P. *Handbook of emerging technologies for learning*, 2009.
[16] Starke-Meyerring, D. & Andrews, D. "Building a Shared Virtual Learning Culture : An International Classroom Partnership", Business Communication Quarterly 69, 25, 2006.
[17] http://www.adobe.com/products/adobeconnect.html viewed 21 June 2012.

Pedagogical model for online learning: the case of System Engineering Subjects at National University of Southern Patagonia

Gabriela VILANOVA
Institute of Applied Technology (ITA), National University of Southern Patagonia
9000 -Juan Jose Paso 513 – B° Palazzo - Comodoro Rivadavia – CHUBUT – ARGENTINA
Phone: 54-297-4549550, e-mail: vilanova@uolsinectis.com.ar

and

Jorge VARAS
Institute of Work, Economy and Territory (ITET), National University of Southern Patagonia
9000 - Juan Jose Paso 513 – B° Palazzo - Comodoro Rivadavia – CHUBUT – ARGENTINA
Phone: 54-297-4549550, e-mail: jrvaras@uolsinectis.com.ar

ABSTRACT

This essay aims to address the challenges faced by teachers in pursuing teaching and learning processes in virtual learning environments at university with a network learning perspective, flexible education and a teaching process design. In this paper, we describe our experience with Unpabimodal system based on Moodle platform at National University of Southern Patagonia Argentina in two System Engineering subjects, Analysis and Design Software and Safety, Health and Environmental Management (Caleta Olivia Academic Unit).
Educational processes have been modified to suit current social conditions. At the same time, the introduction of technology for the educational field has given rise to a new scenario based on the use of ICT (Information and Communication Technology), which provides with a different learning process. Specifically, some experts agree with the idea of showing the key role of the university as "the institution of the network society". In this sense, nowadays higher education institutions have to challenge its former image to suit XXI century students´ interests. As a result, institutions must meet the current demands of society and ensure students acquire the skills needed in the present and future working environment.

Keywords: Pedagogic innovation, virtual learning environment, flexible education, emergent pedagogical models.

1. INTRODUCTION

The characteristics of globalization and the advancement of ICT (Information and Communication Technology) force to develop and carry out strategies to exploit the opportunities they offer in all the areas of modern society. The new teaching systems, configured around telecommunications and interactive technologies, require a redefinition of traditional models to lead students to a more flexible kind of teaching and learning process, such as the one suggested by Unpabimodal pedagogical model. [1] From a pedagogical perspective, approaches related to flexible education, from ordinary classrooms, blended to distant learning, can make a new concept when it provides students with a variety of means and ability to make decisions about learning [2, 3]
There is not only one e-learning model but different enhancements of models of existing learning. [4] They define key terms as follows:

- *Theories of learning* provide accounts of the variables which influence the learning process and explain the way in which that influence occurs.
- *Pedagogical frameworks* describe the broad principles through which theories are applied to learning and teaching practice.
- *Models of e-learning* describe where technology plays a specific role in supporting learning.

The application of ICT training activities under the concept of flexible learning opens several fronts of change and renewal to consider:
• Changes in conceptions (how to work in the classroom, the new teacher´s role, etc.)
• Changes in the basic resources: Files (materials, etc.), infrastructure (technological access, etc.), and open use of these resources for teachers and students.
• Changes in the teachers and students´ practice.

The training methods based on ICT lead to new conceptions of the learning process that emphasize the students 'active involvement not only in the process of building knowledge but also in the emotional and intellectual skills at different levels.

Therefore, the preparation of young people to take responsibility in a fast and ever changing world, requires flexibility to enter a workplace that considers long training and life-skills necessary for this continuous learning [2, 5].

The challenges of organizing the teaching-learning process will depend largely on the stage of learning (the home, the workplace or a learning resource center) and the space-time framework for the users to develop learning activities.

The management of technology projects in higher education institutions cannot be separated from the management of virtual training environments, since in many of the decisions that are made in this process, the context and the practice itself should be considered. The definition of the corporate strategy is the key in any process of introducing an innovation [6-9]. Regarding this strategy and, above all, facing decisions in infrastructure, teacher training, etc., any educational innovation has to be considered as a multi-faceted process which involves political, economical, ideological or cultural factors. This strategy concerns different levels, from the classroom level to university as a whole. The success or failure of educational innovations depends largely on the way different educational actors interpret, redefine, filter and shape the proposed changes.

In conclusion, innovations in the learning process are the main challenge before making individual, group and institutional changes. [10]. The answer to these universities challenges is not standard since each university must respond to its own specificity, based on the context, the society it serves taking into account, basically, the traditions and strengths it has. The institutional implications of the processes of change that the introduction of ICT in university teaching have manifestations in the following aspects:

• Institutional Policy: needed at universities as a corporate strategy involving a formulation of a shared vision of the model of learning.

• Context: Changes occurring in different order such as. population distribution, socio-economical and cultural aspects and the students´own needs (job timetables, academic offer, etc.) Particularly, the context of (UNPA) National University of Southern Patagonia) consists of geographical distribution of dispersed students all over the Southern Patagonia region (provinces of Tierra del Fuego, Santa Cruz and Chubut) of more than 490,000 km², and a population density of 1.2 inhabitants per km².

The UNPA is composed by four academic units located in different cities, separated at least by 800 kms among them: Río Gallegos, Río Turbio, Caleta Olivia and Puerto San Julián. (Fig. 1).

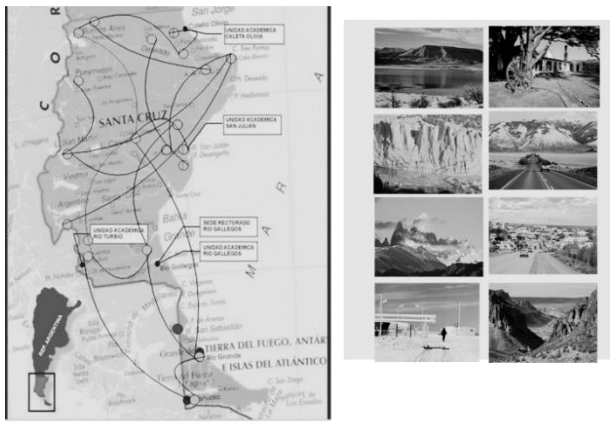


Fig. 1. Area of Influence of the National University of Southern Patagonia

2. PEDAGOGICAL MODEL FOR ONLINE LEARNING AT UNPA: Unpabimodal

Since 2003, UNPA adopted Moodle Platform as its virtual teaching and learning environment and called it "Virtual Environment for Teaching and Learning Unpabimodal" [11]. The virtual environment *Unpabimodal* is composed of a set of virtual classrooms whose main objective is to enhance the students´ better learning in a different pedagogical structure. The structure of the classroom Unpabimodal is shaped by distinct areas: the left side containing general links to Participants, Activities and Administration; the right side with the New Course, Calendar, Events and online users, and the central containing General Issues (such as forms of communication with the team chair, students, the course syllabus, compulsory literature, working plans) and development of the course itself (class materials, activities, resources, thematic units, assessments). (Fig. 2)

Fig. 2. Unpabimodal System Analysis and Design Classroom

A virtual learning environment requires certain components: a *pedagogical* component which refers to learning activities, teaching situations, learning materials , supporting and mentoring at stake, evaluation, etc…;, a *technological* component which refers to the tools selected in connection with the pedagogical model and an organizational or Institutional

component which deals with the organization of the space, calendar, community management, etc.). (Fig. 3)

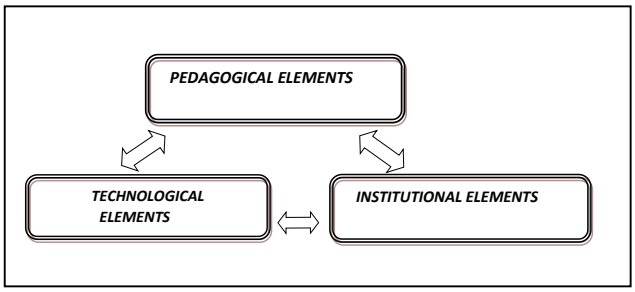


Fig. 3: Virtual learning environment components.

In virtual learning environment management not all the strategies and decisions are made at the same level. It is not the same to define a strategy for an institution interested in an ICT introduction project or for an e-learning corporate project, than define a strategy to design a concrete process of teaching and learning in a virtual environment. Thus, there are three different levels of decisions in the design and development of the possibilities of virtual training environments and these levels will necessarily lead to three types of management documents:

Level 1: *Strategies for the introduction and / or implementation of technology in an e-learning process*. It refers to the management processes of the institutional policy.

Level 2: *Dissemination and implementation strategies in the institution*. At this level, the virtual environment management refers to the process of e- learning as a part of the culture of the institution.

Level 3: *Daily practice and experience* directed to choose the most appropriate combination of methods, tools and techniques to help students achieve desired goals more easily and more effectively. In other words by designing and implementing teaching strategies. [12]. There are four models of on-line teaching presented by Roberts, Romm and Jones (2000), the naïve model, the standard model, the evolutionary model, and the radical model.

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The naïve model may be characterized by the lack of extra facilities provided. As a result, the notes used in live face-to-face lectures are transformed with minimal alteration into a web-based format accessible by a standard browser (such as Internet Explorer or Netscape Communicator). The standard model attempts to actively utilizes the advantages provided by the technology to allow a significant degree of communication and interaction between students and staff. The evolutionary model takes the standard model as a basis and supplements it with many other features to enhance both, the teaching and learning environment. Whereas all three previous models attempt to adapt the traditional face-to-face lecture delivery method to a more suitable web-based format, the radical model dispenses with lectures entirely. Instead, students are formed into groups, and learn by interacting amongst themselves and using the vast amount of existing Web-based resources, with the instructor.

We based our didactic strategy decisions for each Unpabimodal classroom´s subject on Level three, in particular the *Radical model.* We use the following techniques: focused on the individualized teaching (information retrieval, tutorials, exercises, practice through field work, essays, reflections, diagrams, conceptual maps, solving problematic situations); exhibition and large group sharing, collaborative work (work in pairs, and discussion forums, research groups, case studies, questionnaires midterms, virtual classroom sessions with Adobe Connect videoconferencing).

Teaching student-centered. New role of the student

The training, overcoming the barriers of space and time should get advantage and utilizes information technology and communication correctly, and this is only achieved through the forced redesign of the methodological proposals of training programs [14]. These methodological proposals must be based on flexibility, interactivity and collaborative learning in the net, since the fundamental characteristic of learning is carried out in collaboration [15].

The role of the teacher changes from being a domain expert to being a facilitator in the building knowledge by students [16]. Adopting a learner-centered teaching means meeting those attitudes, policies and practice that can increase or decrease the 'distance' of the distant students.

Several authors have studied about the teacher´s function which must be developed by them in learning environments are exploiting the potential of computer-mediated communication. They mention three roles [17]: organizational role, social role and intellectual role, and categorize them into four areas: pedagogical, social, organizational, administrative and technical. However, the same person is not expected to play all these roles.

There are authors that agree to assign the following functions to the teacher [18]:

Organizational: It Provides learning activities, determines the objectives, the timing and patterns of each activity, directs the flow and direction of interactions, provides contextual feedback to solve problems related to the participation rules or time.

Social: the teacher should try to create and maintain a social environment which enables learning, maintain an atmosphere of friendliness, fun and entertainment which favors students over group relationships, development and group cohesion and helps them keep the unit as the group work.

Pedagogical or intellectual: The teacher acts as a facilitator focusing on the most relevant aspects and discriminates irrelevance of the contents, making questions to encourage deep reflections and debate.

Technique: students try to possess skills in communication system, ensuring a certain comfort with the system prior to the beginning of learning activities and ensure that the technology is transparent to them.

As for the changes in the students´ role it is clear that students´ are benefitted in several ways by means of the ICT contact and it advances in this new vision of user training. This requires educational activities related to the use, selection and organization of information so that students will become an autonomous citizen in the information society.

3. CASE OF SYSTEM ENGINEERING SUBJECTS AT UNPABIMODAL CLASSROOM

Software engineering is a discipline for building quality software solutions from different components, which deals with different aspects of the problem to be solved by using a variety of methods, tools, procedures and paradigms. [19, 20, 21]

The characteristics of globalization and the advancement of ICT (information and communication) make teachers develop and carry out strategies to exploit the opportunities offered by all the areas of modern society. Universities generally have adopted ICT mainly in: management, research and for learning processes.

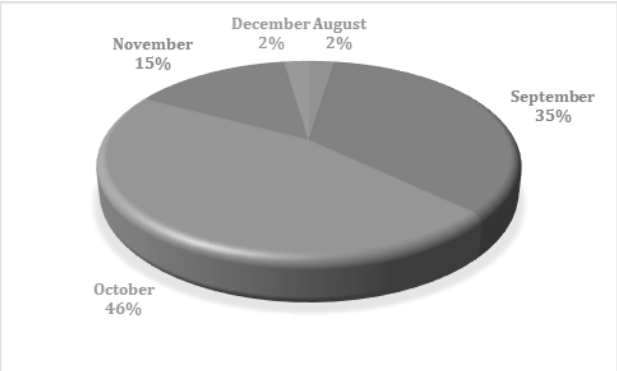
Every day in the software industry, the required skills of the professionals increase. New challenges in offshore software development (development in different geographical locations) and distributed software development require professionals with new skills. These professionals must be trained to perform their work on asynchronous team, collaborate on demand and perform a computer-mediated interaction.

The students are focused on the importance of Risk identification as the first stage of the risk management process. It is concerned with identifying the risks that could pose a major threat to the software engineering process, the software being developed, or the development organization. Risk identification may be a team process where a team gets together to brainstorm possible risks. [22]

Unpabimodal Pedagogical Model considers didactic strategies as the following:

- Strategies focused on individual teaching.
- Strategies for teaching group.
- Strategies focused on collaborative work.

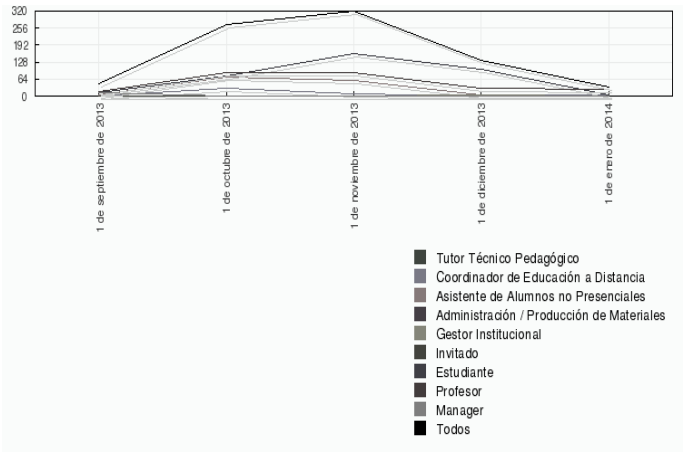
The System Engineering degree program´s subject *Analysis and Design Software*, is a 2nd semester subject. It has been implemented at Unpabimodal classroom since 2004. There is reference material, case studies and solved real industrial problems, previous projects, forums and activities.
The percentage of Interaction in each month can be observed in Graph 1. The highest level of interaction has been observed in October due to Strategies focused on collaborative work (forum, wiki, video conference, etc…).



Graph. 1 Analysis and Design Software Unpabimodal Classroom

The proposed methodology for *Safety, Health and Environmental Management* subject is based on real industry case studies and reflection and debate performed by students´ learned concepts. They must also perform the analysis of a regional industry, real case of their choice, related to oil, gas, mining and power generation.

Reading and research material are available at Unpabimodal environment such as papers, technical reports and notes per unit developing the course contents. Students should submit a task and a lesson for each unit as well as participate in forums as a reflective activity authorized for this purpose.
To develop the real case the resource wiki for collaborative work is enabled by using it as a strategy. Sessions with Adobe Connect videoconferencing are also used.



Graph 2. Safety, Health and Environmental Management Unpabimodal Classroom

The (Graph 2) shows levels of participant's resources views and forum messages in one term of the year (second semester). The highest interaction (November views=350) in forums and wikis can be observed in order to enable collaborative work between them.
There is a decrease in the activity in the last month due to fieldwork that students must take to the completion of the course.

4. CONCLUSIONS

Innovations in the learning process at higher education institutions must respond to University Institutional specificity, context and the society it serves. The institutional implications of the process change because of the introduction of ICT innovation in teaching learning activities which has an impact on several aspects such as an institutional and state Policies.

There are no doubts whether students in contact with ICT are benefitted in several ways and advanced in this new vision of becoming a user trainee. This requires educational actions related to the use, selection and organization of the information so that students go training as a mature citizen member of the information society.

Teachers should prepare students to face the world that surrounds them. Therefore, they should have a thorough knowledge of this so its Professional development should, or should evolve as the society advances.

Because of the fact that most students and teachers´ residence is at least 80 km far from University academic units and sometimes the hardest winter climate conditions do not allow them to reach the university building, a higher percentage of students consider Unpabimodal as a golden education opportunity to suit their needs. As a result, this context is also contributing with people´s inclusion in our region, because since distances are so long, they could not access to university education unless this system is applied.

This university education is then reflected in the specific applications of labor organizations in the region, mainly in local SMEs, which occupy most of the people, consolidating them in service quality, safety and environmental protection.

5. REFERENCES

[1] Collins, B. y Monenn, J. (2001): **Flexible Learning in a digital world**. Kogan Page, London.

[2] Salinas,J. (1997b): **Nuevos ambientes de aprendizaje para una sociedad de la información**. *Revista Pensamiento Educativo, 20*. Pontificia Universidad Católica de Chile pp 81-104 [http://www.uib.es/depart/gte/ambientes.html]

[3] Moran.L. (2001): **Review of flexible learning management at James Cook University**. James Cook University, Curtin (Au).

[4] Mayes, T. and De Freitas, S. (2004), **'Review of e-learning frameworks, models and theories'**, *JISC e-learning models desk study*, available from http://www.jisc.ac.uk/epedagogy/

[5] Lezcano, L. Sosa, C., Vilanova, G., Varas, J. **El Rol del docente universitario en el aprendizaje en red, un enfoque flexible**. 6to. Seminario Internacional de Educación a Distancia. RUEDA (2013).

[6] Bates, A. (2000): **Managing technological change. Estrategies for College and University Leaders**. S.Francisco (CA): Jossey-Bass Inc

[7] Salinas, J. (2004d): **Innovación docente y uso de las tics en la enseñanza universitaria. Revista de Universidad y Sociedad del Conocimiento.** 1 (1) Barcelona (ESPAÑA). [http://www.uoc.edu/rusc/dt/esp/salinas1004.html]

[8] Stiles, M. and Yorke, J. (2003): **Designing and Implementing Learning Technology Projects – A Planned Approach,** *Workshop paper for "EFFECTS - Embedding Learning Technologies Seminar, University College London*, 8th April2003. http://www.staffs.ac.uk/COSE/cosenew/eltfinal.doc

[9] Duart, J. M.; Lupiáñez, F. (2005). **Estrategias en la introducción y uso de las TIC en la universidad.** *Revista De Universidad y Sociedad Del Conocimiento, 2*(1).

[10] Salinas, J. (2004a): **Hacia un modelo de educación flexible: Elementos y reflexiones.** En Martínez, F.; Prendes, MP.(coord.): Nuevas Tecnologías y Educación. Pearson/Prentice Hall. Madrid. 145 -170.

[11] **Informe del Sistema Educativo de Enseñanza y Aprendizaje Unpabimodal**. Consejo Superior Agosto 2009. UNPA (Univerisidad Nacional de la Patagonia Austral) www.unpa.edu.ar/unpabimodal

[12] Salinas,J. (1997b): **Nuevos ambientes de aprendizaje para una sociedad de la información**. *Revista Pensamiento Educativo, 20*. Pontificia Universidad Católica de Chile pp 81-104 [http://www.uib.es/depart/gte/ambientes.html]

[13] ROBERTS,T., ROMM,C. Y JONES, D. (2000): **Current practice in web-based delivery of IT courses**. *APWEB2000*.

[14] Ferraté, G. (2003) **Els reptes de la societat del coneixement.** Artículo publicado en el periódico 20 minutos. Barcelona, 19 de marzo de 2003.

[15] Harasim, L.; Hiltz, S. R.; Turoff, M; Teles, L. (2000). **Redes de aprendizaje. Guía para la enseñanza y el aprendizaje en red**. Barcelona: Gedisa.

[16] Pérez I Garcías, A. (2002). **Nuevas estrategias didácticas en entornos digitales para la enseñanza superior**. Salinas, J. y Batista, A. (Coord): *Didáctica y Tecnología Educativa para una universidad en un mundo digital*. Imprenta Universitaria. Universidad de Panamá.

[17] Heeren, E.; Collis, B. (1993). **Design considerations for telecommunications-supported cooperative learning environments: concept mapping as a telecooperation support tool**. *Journal of Educational Multimedia and Hypermedia* (vol. 4, n.º 2, pág. 107-127).

[18] BERGE, Z. L., COLLINS, M. (1995): **Introduction: Computer-Mediated communications and the Online Classroom in distance learning**. En BERGUE, Z., COLLINS, M. (Eds): Computer Mediated Communication and the Online Classroom, Vol. III: Distance Learning. Cresskill, New Yersey, Hampton Press, pp:1-12

[19] Manjarres, A., Arias, M., Gaudioso, E. **Transverse Competencies in software engineering teaching (In Spanish)**. VI Jornadas de Redes de Investigación en Docencia Universitaria, Universidad de Alicante. 2008.

[20] Dick, B. Simmons, R. Software. **Engineering Education in the New Millennium**. Proc. of the 30th Annual International Computer Software and Applications Conference (COMPSAC'06). IEEE Press.2006.

[21] Hawthorne, M., Dewayne, E. **Software Engineering Education in the Era of Outsourcing, Distributed Development, and Open Source Software: Challenges and Opportunities.** Proc. of the 27th Int. Conf. on Software Engineering (ICSE). St. Louis, USA. Pages: 643 - 644. 2005.

[22] Sommerville, Ian. **Software engineering, 9th ed.** p. cm. ISBN-13: 978-0-13-703515-1. (2009). Addison Wesley

A Novel Design for Smart App Firewall Framework

Hesham F. Ali
Computers and Systems Department, Electronics Research Institute,
Cairo, Egypt.
hesham@eri.sci.eg

Bassem A. Abdullah
Computer and Systems Engineering Department, Ain Shams University,
Cairo, Egypt.
babdullah@eng.asu.edu.eg

Atheer Mostafa
CIO, Starware
Cairo, Egypt
Atheer@startware.net

ABSTRACT

The big and continuously developing web sites, tens of thousands of them redeveloped their code considering secure coding with more interest although this still was not still enough because a single critical vulnerability in a single line in a single page could lead to full website hack and all information disclosure.

In this paper we propose a system aiming to design application for firewall, depending on using the learning based whitelist rules in addition to the classical method of using black list rules. The concept was evaluated by generating these white rules manually and showed excellent performance when tested in websites of STARWARE company clients who involve high traffic daily like "Youm7" Press. In this paper, we target applying an artificial intelligent learning engine such as Artificial Neural Network (ANN), Support Vector Machines (SVM), etc to automate updating the rules of the whitelist extending the concept proved in our commercial platform.

The proposed application is targeting enhancing the system performance by minimizing the traffic with percent more than 90% from internet traffic and web page download time will be reduced by more than 50%. The filters to be build is targeting better detection with more than 50% with respect to the running today filters applying on more 10K rules.

Keywords: Blacklist, Whitelist, Neural network, DNS, Firewall, Varnish, Reverse Proxy.

1. INTRODUCTION

Almost all -even big and famous- websites and services till now have been hacked several times. Recently, website hackers have begun to develop attacks that target vulnerabilities in the business logic, rather than in the code itself. Business logic attacks are often not looked upon as security risks but hold serious business implications for website owners because they generally remain undetected [1].

The well-known brands firewalls and expensive network security devices are not able to cover this aspect because all these vulnerabilities are standing in the application layer; the seventh layer in Open Systems Interconnection (OSI) model, and are very hard to detect without fully understanding the logic of the developer while being able to control successfully up to the fifth layer in the network OSI model.

The most common example of this is comment spam. This is where hackers insert automatically generated comments into a blog or online forum, directing people to bogus sites that promote bogus pharmaceuticals when it's actually malware. The implications of such attacks can range from degradation in your company's search engine rankings to being blacklisted and completely removed from search results. So, all data used by the website (from users, other servers, other websites and internal systems) must be validated for type (e.g. numeric, date, string), length (e.g. 200 characters maximum, or a positive integer) and syntax (e.g. product codes begin with 2 letters and are followed by 5 digits) and business rules (e.g. televisions can only cost between 2000 EGP and 8000 EGP, an order can contain at most 20 items, daily credit limit must not be exceeded). All data written as output

(displayed) needs to be safe to view in a browser, email client or other software and the integrity of any data that is returned must be checked [2].

Our solution is based on the growing and widely used caching platform "Varnish". It's well tested and open source for extension and development. We can implement the system in matrix of any clustered servers to provide a cloud based matrix and could be distributed geographically. This will make the solution great stable and performance efficient to perform in high volume traffic with least costs. With the use of one of a famous artificial intelligent engine such as neural network, it will receive the output of the "Varnish" and generate whitelist rules.

In this paper, Section 2 will give an overview for the history and state of the art of the web site security models, Section 3 will represent the proposed system and section 4 will give the conclusion.

2. HISTORY AND STATE-OF-THE-ART

Most of the critical hacking techniques are based on sending commands within data parameters to the web page considering that data inputs will be concatenated later with developer commands to be executed, this is very clear in SQL Injection, Cross Site Scripting, File Inclusion, Buffer Over Flow, Command Execution … etc

On 2003 we considered building a library through an intelligent security code review application to fix the SQL Injection vulnerability specially and replace all input reading inside the ASP code with a security developed library to filter all parameters based on their log of behaviour. The first mode of this security library is logging mode, in which the parameters values are logged and saved in a specific database for some time of using the site pages all features. Then a filter generator will be used to analyze the log database and output specific filtration rules in Visual Basic syntax to be added into the security library and compiled as a DLL. The last step is to bind this DLL with the ASP website, and run the security library in filtration mode using the DLL filters for all parameters that learned, and apply a basic security for the parameters that are in new pages to be logged and added for next use of the security hardening process to add the new parameters rules. Basically the rules were considering parameters data types validation to protect numeric parameters from SQL Injection, and also protect string parameters being escaped by a single quote for SQL Injection too. Simple rules for file inclusion are applied manually to the rules DLL.

On 2011 STARWARE (as a company) started implementing Cloud Cache servers to provide performance and basic security; that is based on Reverse Proxy technology on external system/servers to provide simple static and dynamic content caching rules written in VCL language to be used in Varnish system as a reverse proxy to the original servers. Varnish – as an open source reverse proxy - converts VCL rules to C++ to be compiled as binaries on the fly for very fast execution in memory that enables processing 10,000 to 40,000 requests per second. The main need to this solution was for performance, stability and basic security including a Blacklist parameter filtering in VCL to the Varnish configurations to protect and block the direct and common cases of SQL Injection specially used by tools and vulnerability scanners.

The blacklist model is to exclude and filter the keywords and patterns used commonly in exploiting a security vulnerability, this requires including all keywords and functions and special function in all version used in the database management system. As example, there are hundreds of MySQL functions, other hundreds in SQL Server, others for Oracle, and PostgreSQL …etc. There are usually hundreds of Filter Evasion and Filter Bypassing techniques and tricks on the web; that's why blacklisting is not efficient enough for security against hackers (this can prevent only script kiddies hackers that are using tools without security and development knowledge).[3-6]

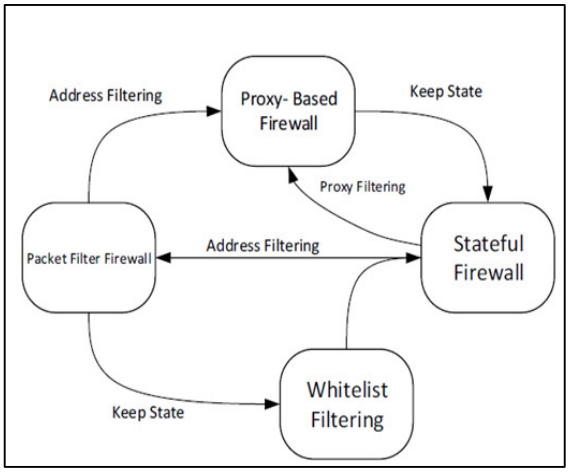


Fig. 1. Diagram for the whitelist Firewall

The Whitelist model is more efficient and this is the model that already implemented while configuring Network Firewalls [7-8], but implementing it in IDS (Intrusion Detection Systems) or IPS (Intrusion prevention system) is so difficult to implement because it requires very detailed and professional rules writing in Regular Expressions which, usually requires a skilled professional with development background to write these rules with cooperation with web application developer. This is not flexible and requires a lot of time and efforts and requires dedication of the developer with the security professional for this task which is not practical and sometimes impossible after handing over of the development company, also it is impossible in compiled and closed code sites to make this kind of security enhancements by whitelisting in most cases

and will result in several issues of incorrect configurations that are hard to debug and troubleshoot. Fig. 1 gives a brief view about whitelist firewall.

3. THE PROPOSED SYSTEM

The proposed system is targeting to automate the rules writing, which requires well knowledge of the parameters (including cookies) in many tracks; the data types, the data length, output structure, output format and output size. In actual web site usage of learning is similar to the basic idea that we implemented simply 10 years ago in the ASP and DLL case, but in more advanced and professional engineering technology.

We can basically write parameters logging to "Varnish" in the learning mode. In this mode we test all site services with normal traffic usage, and then apply this log over a modern machine learning technique to define page specific and parameter specific rules and write their related VCL rules file. Next, implement this file as a security configuration for this web site. The parameters will be validated and filtered in the ordinary "Varnish" fast processing without effect on the original application code or without performance impact. On the other hand, we will gain great performance and high availability features.

Fig 2. Represents a simple comparison between the classical flow between any internet user with any web site with respect to the process between any internet user and any website but within the control from the smart app firewall system

Fig 2: System layout with Smart app firewall versus Classical firewall

The proposed system is composed mainly from 3 phases:
Phase 1: User request analysis.
Phase 2: Controller and Reverse proxy.
Phase 3: Rules generation and Learning.

The system workflow is as follows:
Phase 1: User request analysis

1. User request will be received by smart app firewall.
2. The request will be redirected through Geo-DNS to the cloud network.

Phase 2: Controller and Reverse proxy

3. Cloud network will route the request to the "Varnish" reverse proxy.
4. "Varnish" controller will apply the Whitelist and Black list rules:
   a. Approved request : go to the requested web server
   b. Not approved: block and send to web interface as alert of hack attempt to be displayed to the security monitoring specialist.
5. If the request is from trusted IP, the controller will send it to the learning module.

Phase 3: Rules generation and Learning.

6. The learning module will analyze the request using machine learning techniques.
7. The learning module will generate whitelist rules.
8. The resulted rules will update the application firewall whitelist rules.

Fig. 3 gives a summary to the workflow for a user request as described above.

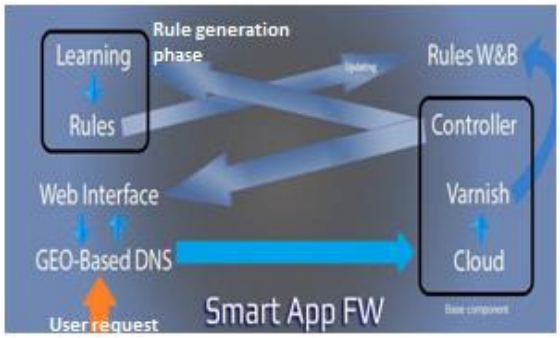


Fig 3: Smart App FW flow

For the whitelist rule engine, the neural network or the SVM used will learn from a trusted user behavior to build a whitelist that will be the source of the rules while the blacklist will remain to be the same used by traditional app firewall. In case of using SVM, one of kernels commonly used like Radial Basis Function (RBF) might be used benefiting from its ability of modeling non-linear models [13].

The proposed research in learning is based on:

- Using Neural Networks [9-11], Support Vector Machines (SVM) [12-14] to build a whitelist rules learning model and other machine learning techniques.
- Comparing between the performances of the machine learning techniques and select the appropriate technique.
- Propose a new learning model if needed that fits the learning of the rule generation phase.

4. CONCLUSION

Implementing machine learning technique for the user usage analysis will be more effective. Being easy to implement external of the web server and even external of the datacenter will enable it to be provided as a cloud service for customers. Cloud Caching & Security is already implemented and used to decrease the traffic usage; this is provided as cloud service for web site owners as CloudFlare or Incapsul and their services are relatively expensive. These systems don't provide learning security rules writing and implement very primitive blacklists for their application firewalls. This is also used by ISPs to reduce the external traffic usage by caching the commonly used sites static content (knowing that static content is about 90% or more of the web page).

The proposed smart application firewall is enhancing the system performance by minimizing the traffic with more than 90% from internet traffic and web page download time is reduced by more than 50%. The filters get better detection with more than 50% with respect to running today filters applying on more 10K rules.

5. REFERENCES

[1] "**9 Things Businesses Need to Know About Web Security**", http://mashable.com/

[2] "**Top 10 website security issues**", Watson Hall Ltd, 2009.

[3] http://www.bbc.co.uk/arabic/worldnews/2013/09/130929_uk_cyber_unit.shtml

[4] Ahmed Amin, H. Farouk,Ahmed Mahmoud, Heba Aslan, "**A Design for an FPGA Implementation of RIJNDAEL CIPHER**", Journal of Programmable Devices, Circuits, and Systems, International Congress for Global Science and Technology (ICGST), 2009.

[5] H. Farouk, A. Tobal, "**An Efficient Detection and Classification Method for Landmine Types Based on IR Images Using Neural Network**", International Journal of Geology, pp. 91-95, Issue 1, Volume 4, 2010.

[6] B. Abdullah, A. Younis and N. John, "**Multi-Sectional Views Textural Based SVM for MS Lesion Segmentation in Multi-Channels MRIs**," The Open Biomedical Engineering Journal, vol.6, 2012, pp. 56-72. doi:10.2174/1874230001206010056

[7] https://www.owasp.org/index.php/Web_Application_Firewall

[8] https://www.owasp.org/index.php/Category:OWASP_Best_Practices:_Use_of_Web_Application_Firewalls

[9] B. Abdullah, A. Younis P.M. Pattany, and E. Saraf-Lavi, "**Textural based SVM for MS Lesion Segmentation in FLAIR MRIs**," Open Journal of Medical Imaging, vol.1, pp. 16-42. doi: 10.4236/ojmi.2011.12005, 2011.

[10] Bassem A. Abdullah, A.A. Younis (UM-ECE_team) in Workshop of "**MS Lesion Segmentation Challenge 08**". Results accepted to appear on the ranked online results on Oct. 10, 2011.

[11] Oliver Coleman, O.J., Blair A.D., "**Evolving Plastic Neural Networks for Online Learning: Review and Future Directions**"., Proceedings of the 25th Australasian Joint Conference on Artificial Intelligence (AJCAI'12), Sydney, Australia, 2012.

[12] Guoqiang Peter Zhang "**Neural Networks for Classification: A Survey**", IEEE transactions on systems, Man and Cybernetics part C: Applications and Reviews, VOL. 30, NO. 4, NOVEMBER 2000.

[13] Chih-Chung Chang and Chih-Jen Lin, "**LIBSVM: A library for support vector machines**", ACM Transactions on Intelligent Systems and Technology, vol. 2, no. 3, pp. 1-27, 2011, Software available at http://www.csie.ntu.edu.tw/~cjlin/libsvm.

[14] A Pozdnukhov and M Kanevski, "**Monitoring Network Optimisation for Spatial Data Classification Using Support Vector Machines**", International Journal of Environment and Pollution, vol. 28, 2006.

ADTOS: Arrival Departure Tradeoff Optimization System*

Samet Ayhan Paul Comitz

Gary Gerberick Ian Wilson

Boeing Research & Technology
15059 Conference Center Dr.
Chantilly, Virginia 20151
{samet.m.ayhan, paul.comitz, gary.d.gerberick, ian.a.wilson}@boeing.com

ABSTRACT

This paper develops a novel automated decision support system, named ADTOS, intended to assist traffic flow management specialists select the most optimal arrival and departure strategies. We have built and maintained a data warehouse using streams of aviation data as part of an internal research and development project at Boeing Advanced Air Traffic Management in Chantilly, VA. ADTOS leverages this data warehouse, making use of Aircraft Situation Display to Industry (ASDI) surveillance, Meteorological Aerodrome Reports (METAR), Terminal Aerodrome Forecast (TAF) data, and runway configurations. The warehouse database architecture and the arrival/departure tradeoff optimization module is presented with a validation case study in which ADTOS is utilized for strategic planning of arrival and departure traffic and airport capacity from 1 hour to 24 hours into the future at Dulles International Airport (IAD).

Categories and Subject Descriptors

H.2.4 [**Information Systems**]: Database Management—*Systems*

General Terms

Algorithms, Design, Performance

Keywords

Air traffic management, flow management, data stream management, information extraction, data analytics

1. INTRODUCTION

The current levels of congestion are an indicator of the fact that restricted capacities/constraints in the NAS are unable to meet growing air traffic demand, resulting in costly delays. Although air traffic controllers (ATC) perform traffic flow management using various tools and techniques with all necessary data to alleviate the problem, the outcome may not deliver the most optimal solutions with best performance in an automated fashion, causing additional increase in ATC workload. Many attempts have been made to model and predict likely losses in capacity to allow stakeholders in the NAS to take corrective actions to ameliorate the system delays [18, 16, 8, 10, 17, 12, 13, 14, 15, 11]

ADTOS is a novel system to optimally sequence arrival and departures at airports, introducing a greater degree of automation and decision support for traffic flow management. It is driven by data from an aviation data warehouse [9] continually updated by live data sources

The rest of this paper is organized as follows: In Section 2, we explain the overall architecture of ADTOS, in Section 3, we introduce data sources and present the database design. Section 4 discusses the arrival/departure tradeoff optimization module. Section 5 presents a case study: arrival/departure tradeoff optimization at Dulles International Airport. The final section contains concluding remarks and suggested future work.

2. ARCHITECTURE

ADTOS is built upon an aviation data repository using IBM's InfoSphere Warehouse [3], where ASDI [1], METAR [6], and TAF [7] data are stored. Requests coming through a web interface are passed onto an arrival/departure tradeoff optimization module. Per an incoming request, the optimization module connects to the database, retrieves the relevant data, runs the algorithm and responds to the request with the recommended strategy, presenting the results on the web page. Each retrieval action is posed in terms of a corresponding query of the aviation data repository.

Figure 1 is a graphical overview of the system architecture, where components are connected to each other with arrows indicating data flow.

Back end processing is illustrated with green components and comprised of interim and final partitioned databases, an XML shredder, and the arrival/departure tradeoff optimization module. The XML Shredder, comprised of a set

*This work was funded by BR&T Service-Oriented Aviation Information Management (SOAIM) Internal Research and Development (IR&D) project.

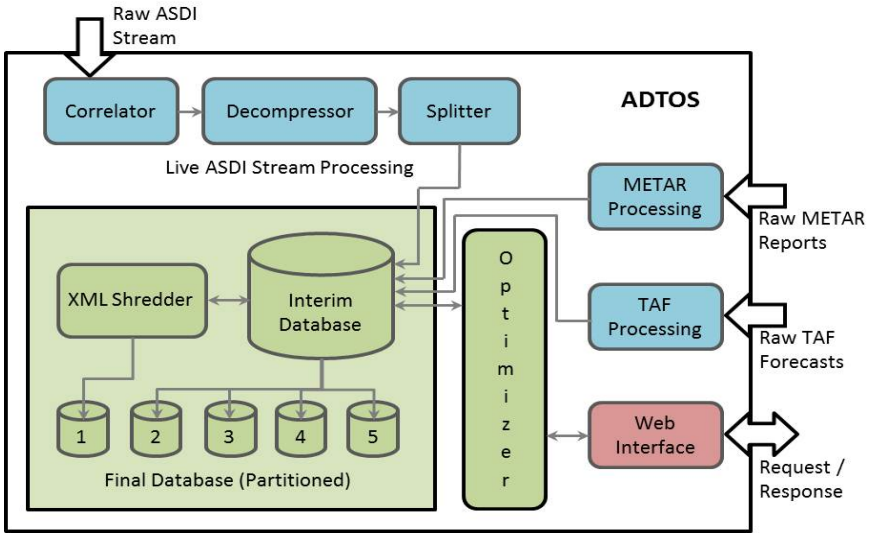


Figure 1: Graphical Overview of ADTOS.

of stored procedures, parses out raw individual ASDI messages and puts their content into separate tables in the interim database. Tables are partitioned by month across the external drives.

The front end module is a web interface powered by IBM's Cognos Business Intelligence (BI) [2], illustrated with a red component.

Data sources and pre-processing modules are illustrated with blue components. The database is fed using streams of aviation data.

3. DATA SOURCES AND DATABASE DESIGN

This section presents data sources and the database design.

3.1 Data Sources

ADTOS uses three main data sources, ASDI stream, METAR report, and TAF forecasts that are handled separately.

The ASDI data feed is a continuous stream of messages delivered over a TCP/IP network socket from an upstream ASDI vendor. The stream consists of data packets containing *Zlib* compressed XML documents of ASDI messages with binary headers.

Figure 2 shows the number of ASDI messages processed by hour throughout a single day, June 5, 2013. Note that a total of over **30 million ASDI messages** are processed in any single day.

ASDI messages can be flight plan related data, oceanic reports, or host track reports. During the initial stage of the processing, a TCP/IP live ASDI stream is consumed by a message flow where messages are sorted and pushed to related queues based on their message types. This near real-time data consumption is handled by IBM WebSphere Message Broker [4] and MQ [5]. Correlator is in charge of correlating various message types. Its purpose is to tag flight

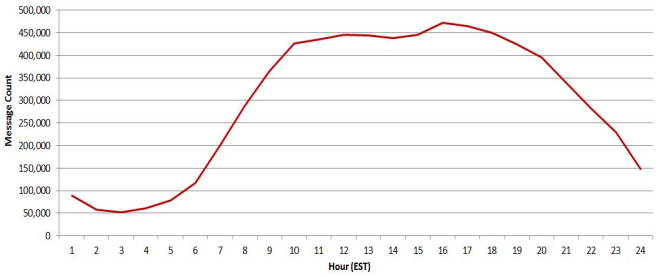


Figure 2: Number of ASDI messages processed throughout June 5, 2013.

plan and track messages from multiple Air Traffic Control (ATC) centers relating to the same flight with a unique identifier called the (`FLIGHT_KEY`). Decompressing *Zlib* files with XML content comes next. The final step in processing is splitting a set of ASDI messages into individual messages.

METAR is an international format for reporting airport weather information. The report is a weather observation near ground level from an airport station containing information such as date, time, wind, visibility, and temperature. A TAF is a concise statement of the expected meteorological conditions at an airport during a specified period (usually 24 to 30 hours). Arrival/departure tradeoff optimization engine makes use of TAFs to best match the arrival/departure capacities given the meteorological conditions at an airport.

3.2 Database Design

ADTOS' database was designed with Quality of Service (QoS) requirements such as performance, throughput, and high availability in mind so that the vast amount of data streaming and processing can be managed. When an optimization request is received through its web interface, ADTOS is designed to respond with the most up-to-date accurate data available in the database with the best performance. To

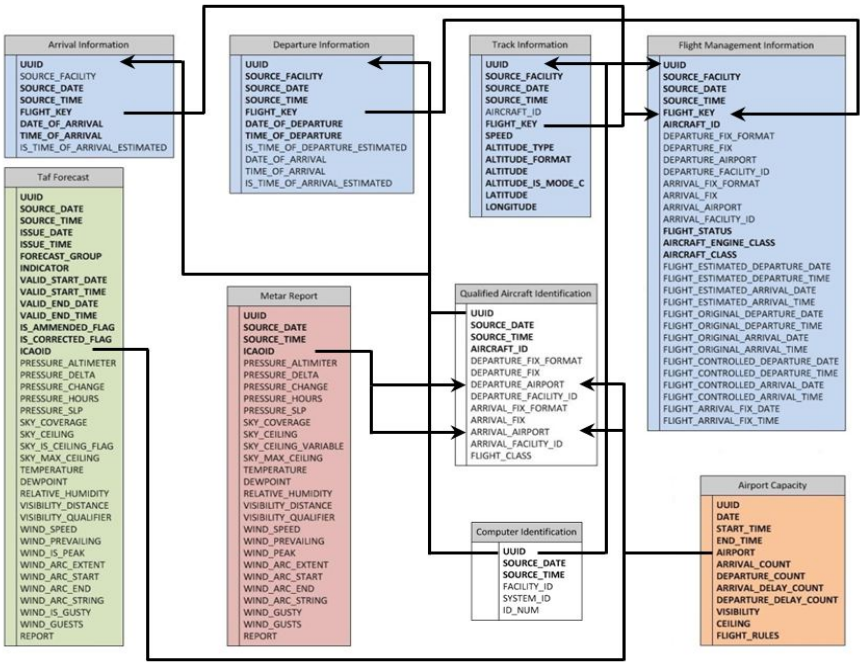


Figure 3: Overview of ADTOS' database schema.

address this goal, ADTOS employs a number of tools and techniques including a central DB2 relational database that stores all data received and further refined from processing. ADTOS also employs IBM WebSphere Message Broker and MQ to meet critical QoS requirements.

Figure 3 is an overview of ADTOS' database schema, showing the tables used for ADTOS' core data processing.

Tables are color coded: Blue relates to ASDI data, red for METAR, and green for TAF forecasts. Transparent ones are the supporting tables. There is an additional table coded orange indicating that it is populated by running queries against these major three data sources. The orange table is populated overnight, providing custom data for the arrival/departure tradeoff optimization module. Note that the figure depicts a simplified version of the ADTOS' database, which currently contains over 100 tables, but these few serve as a useful illustration of the core data and functionality present in ADTOS, as well as the general database design strategy.

Note that (`ICAOID`) and (`Airport`) are used interchangeably in the tables. Transparent supporting tables connect to ASDI main tables (blue) using (`UUID`), whereas ASDI main tables connect to each other using (`FLIGHT_KEY`). Bold fields in the tables indicate the fact that they are required, whereas others are optional.

The ADTOS' database schema was designed with potential queries in mind so that the best response performance can be achieved for requests. Therefore, database tables reflect incoming raw messages in XML. The tables are created based on classes generated from schema definitions for the correlated ASDI, METAR and TAF data.

4. ARRIVAL/DEPARTURE TRADEOFF OPTIMIZATION MODULE

Gilbo et al identified the fact that almost all capacity-constrained major airports with certain runway configurations have arrival and departure capacities that appear interconnected. Hence, arrival capacity can be increased at the expense of decreasing departure capacity and vice versa [12]. Therefore, an arrival/departure tradeoff optimization module was implemented for ADTOS that performs the following steps:

- Upon a request received via web interface, the module gathers the input parameters such as date, time interval, weight coefficient, and airport code.
- Based on the input parameters, it connects to the relevant database partition and proceeds as follows:
  - It determines whether the meteorological conditions indicate IFR or VFR at the requested airport given the date/time inputs using TAF data available in the database.
  - Per weather conditions forecasted at the specified airport, the module pulls the relevant arrival and departure capacity values from the database. Note that arrival and departure capacity values are computed based on historical values and updated nightly considering the most up-to-date data.
  - The module retrieves expected arrival and departure demands from the database in the form of 15 minute bins using ASDI flight plan data in the database.

Table 1: Determining IFR and VFR Operational Categories based on ceiling and visibility values

Category	Ceiling	Visibility
IFR	<1000ft	<3mi
VFR	≥ 1000ft	≥ 3mi

  - Considering weight coefficient provided by the user, the algorithm performs optimization computing the minimum cumulative arrival and departure queues. This way, the demand is best met by the capacity allowing the optimal number of arrivals and departures.

- The final result is presented to the client through a web interface.

The Linear Programming (LP) model of the optimization problem can formally be formulated as

$$\max_{u^*} \sum_{i=1}^{N} (\alpha u_i + (1-\alpha) v_i), \quad 1 \geq \alpha \geq 0$$

where α is the weight, u_i is the airport arrival capacity at the ith time slot, and v_i is the airport departure capacity at the ith time slot [12]

5. VALIDATION - A CASE STUDY AT IAD AIRPORT

Arrival and departure delays were identified at IAD from historical data. A time period was then identified in which ADTOS optimally sequenced arrival and departures to minimize the cumulative flight delays. The final results were then validated by comparison with the actual airport performance in the same time period.

IAD is one of the three major airports in the Washington, DC metro area. It has four active runways: three parallel runways 19R, 19C, and 19L, and runway 30. There is a planned runway, 30L that is not currently used. Unlike other major airports such as Atlanta Hartsfield, where each runway is a dedicated single mode runway, IAD runways are multimode i.e. used for both arrivals and departures, making it a good fit for our study.

The case study uses historical data for the time period of June 1-30, 2013 to identify delays and generate arrival/departure capacity curves. Two simplified operational weather categories are used, IFR and VFR. Table 1 shows the rules used for determining these categories.

5.1 Flight Delays at IAD, June 1-30, 2013

In this study, flights arriving or departing 60 seconds or more after the time indicated in the latest filed flight plan including amendment are considered delayed

To identify delays at IAD, we populated corresponding fields in the Airport Capacity table by retrieving 1-hr counts of arrival and departure delays. Delays were determined by comparing the time in the flight plan with the actual arrival and departure times. Averaging the arrival and departure delays per 1-hr bin for the entire month of June 2013 generated Figure 4.

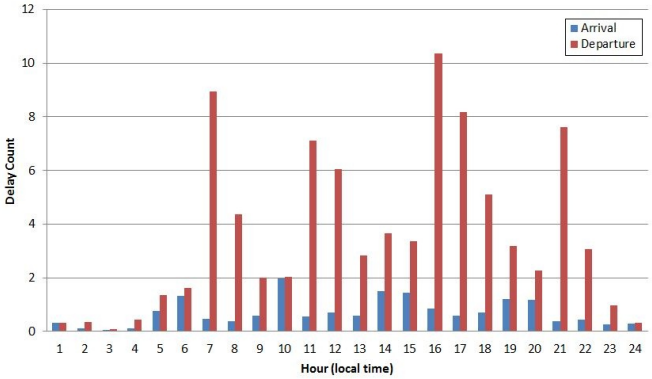
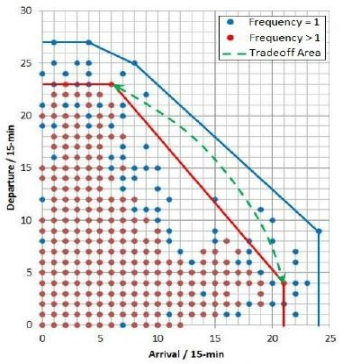


Figure 4: IAD flight delays, for the June 1-30, 2013 time period.



Arr	Dep
21	4
20	5
18	8
17	9
14	13
13	14
10	18
9	19
6	23

Figure 5: IAD airport capacity curve under VFR and the corresponding tradeoff values for the June 1-30, 2013 time period.

Figure 4 shows that even though average delay count per hour for arrival doesn't exceed 2, average delay count per hour for departure can be 10 or more. These figures appear to indicate that there is congestion at IAD, and that current mechanisms are insufficient and will not meet the growing air traffic demand; thus, the airport capacity is insufficient and an alternative way of optimization seems to be needed.

5.2 Arrival/Departure Tradeoff Optimization Test Scenario

In this test scenario ADTOS processes a time period in the near future to optimally sequence the arrival and departures in order to minimize cumulative flight delays. The test scenario is executed on Monday, July 1, 2013 at 8:00AM local time, to optimize the flights from one to three hours in the future between 9:00 and 11:00AM local time at IAD.

The execution steps for the scenario are as follows:

- ADTOS uses the latest capacity curves for all runway configurations to determine operational limits.
- ADTOS checks TAF forecasts to identify operational category for the time period of interest.
- Given the category, ADTOS retrieves the relevant capacity table (generated from the capacity curve).
- ADTOS uses flight plan data to determine arrival/departure demands for the time period of interest.
- Provided the capacity and demand tables, ADTOS optimizes the flights.

As ADTOS is driven by data from an aviation data repository that is being continually updated by live data sources, it has the ability to generate and update capacity curves nightly as a batch process. To do this, ADTOS populates the Airport Capacity table that contains 15-min bins for counts of arrivals and departures per airport and the operational weather categories identified as IFR or VFR by simple visibility and ceiling values.

Figure 5 is illustration of IAD airport capacity curve under VFR operational condition and the arrival/departure capacity pairs within the tradeoff area. In the left figure, the coordinates of each point indicate the number of arrivals and departures realized at the airport during the same 15-min interval. The capacity curve is estimated by stretching a piecewise-linear curve over the set of points. To ensure the estimation is robust, ADTOS rejects outliers that can be considered as rare events when the airport operates beyond its operational limits for a short period of time. In the left figure, the red curve indicates the robust estimates and the blue curve the non-robust estimates of the capacity curve [12].

Note that ADTOS used actual historical ASDI and METAR data based on 15-min counts over the period of entire month of June 2013 to generate these capacity curves. ADTOS determines from the weather records that the operational category for the time period of interest is VFR. ADTOS pulls the relevant capacity table indicating the operational limits.

Using operational category for the time period of interest, ADTOS retrieves 15-min counts of arrival and departure demands (9:00AM to 11:00AM EST). Airport demand is determined by using the continually updated flight plan records in the warehouse. Table 2, Column 2 (DEMAND) contains 15-min counts of arrival/departure demands under VFR category for the time period of interest (9:00AM to 11:00AM local time).

The final step in the process is optimizing the arrival/departure sequence. ADTOS finalizes the optimization by keeping all flights served with the cumulative arrival/departure queue of 42. The flow management specialist can further alter the ADTOS' optimization to experiment with alternative sequencing by selecting different arrival/departure variations through the pull down menu as illustrated in Figure 6.

5.3 Validation

In order to validate ADTOS' optimization, we reviewed the actual traffic flow for the time period of interest. Table 2 shows the initial demand, actual traffic flow, and the arrival/departure queue counts in July 1, 2013 between 9:00 and 11:00AM local time.

As shown in Table 2, 59 arrivals were not served, keeping the cumulative queue count at 363.

The case study indicates that ADTOS is able to more optimally sequence arrivals and departures and so minimize the cumulative flight delays, solving the combinatorial optimization problem at the IAD airport. The results ADTOS attained appear to be a significant improvement on the actual arrival and departure traffic flows.

6. CONCLUSION AND FUTURE WORK

ADTOS is a novel automated decision support system to assist in optimally load sharing between arrival and departures at airports, utilizing information from an aviation repository, which is the information base supporting ADTOS. The simple validation exercise used information on arrivals and departure traffic flows at IAD airport. The results indicate that there may be value in the ADTOS approach of prioritizing one flow over another which in this simple approach increased the IAD airport throughput and reduced the traffic delays. Although ADTOS offers a potential capability to assist in reduction of traffic delays, the work so far is experimental and more research is required. The tool currently handles a single airport at a time disregarding other airports in NAS with connecting flights and airspace congestion. In order to better assess delays and offer an optimal solution, NAS will need to be assessed as an entire system. Additionally, a critical data source, airport surface data (ASDE-X) has not yet been included in the data warehouse. Our plan is to utilize ASDE-X in the future to more accurately determine arrival/departure times at airports.

7. REFERENCES

[1] Aircraft situation display to industry: Functional description and interface control document for the xml version. http://www.fly.faa.gov/ASDI/asdi.html, 2011.

[2] IBM - cognos business intelligence. http://www-01.ibm.com/software/analytics/cognos/business-intelligence/, 2012.

[3] IBM - data warehouse - infosphere. http://www-01.ibm.com/software/data/infosphere/warehouse/, 2012.

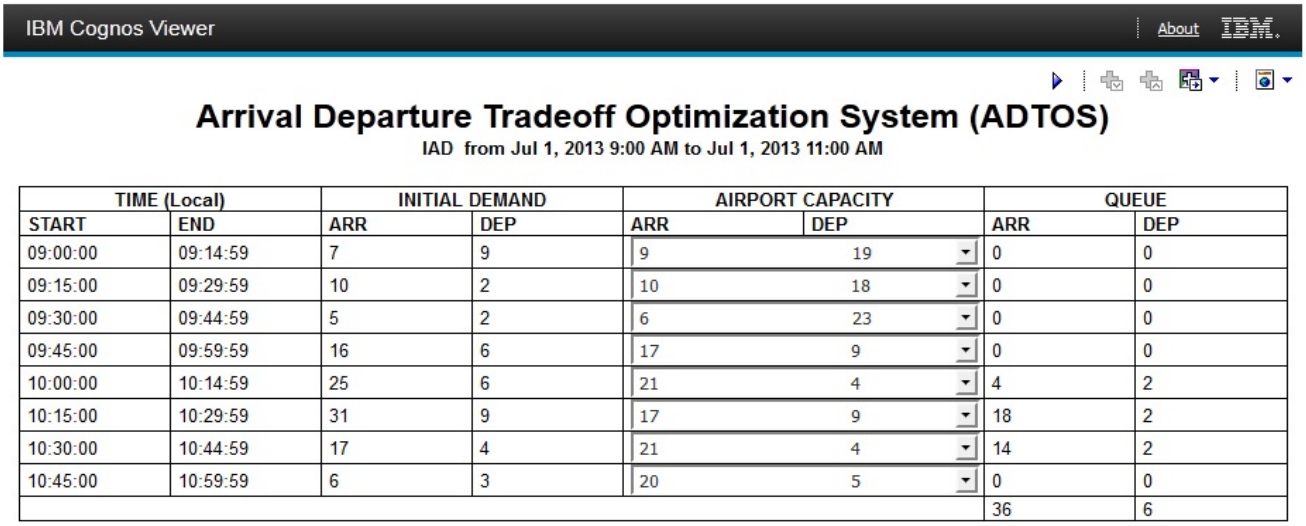
[4] IBM - websphere message broker. http://www-01.ibm.com/software/integration/wbimessagebroker/, 2012.

[5] IBM - websphere mq. http://www-01.ibm.com/software/integration/wmq/, 2012.

[6] Meteorological aerodrome report. http://www.aviationweather.gov/adds/metars/, 2013.

[7] Terminal area forecast. http://www.aviationweather.gov/adds/tafs/, 2013.

[8] K. Andersson, W. Hall, S. Atkins, and E. Feron.



TIME (Local)		INITIAL DEMAND		AIRPORT CAPACITY		QUEUE	
START	END	ARR	DEP	ARR	DEP	ARR	DEP
09:00:00	09:14:59	7	9	9	19	0	0
09:15:00	09:29:59	10	2	10	18	0	0
09:30:00	09:44:59	5	2	6	23	0	0
09:45:00	09:59:59	16	6	17	9	0	0
10:00:00	10:14:59	25	6	21	4	4	2
10:15:00	10:29:59	31	9	17	9	18	2
10:30:00	10:44:59	17	4	21	4	14	2
10:45:00	10:59:59	6	3	20	5	0	0
						36	6

Figure 6: ADTOS' optimization.

Table 2: Actual Traffic Flow

TIME		DEMAND		FLOW		QUEUE	
Start	**End**	**Arr**	**Dep**	**Arr**	**Dep**	**Arr**	**Dep**
9:00:00	9:14:59	7	9	1	5	6	4
9:15:00	9:29:59	10	2	2	2	14	4
9:30:00	9:44:59	5	2	5	2	14	4
9:45:00	9:59:59	16	6	4	2	26	8
10:00:00	10:14:59	25	6	9	3	42	11
10:15:00	10:29:59	31	9	13	5	60	15
10:30:00	10:44:59	17	4	16	0	61	19
10:45:00	10:59:59	6	3	8	6	59	16
					Total	**282**	**81**

Optimization-based analysis of collaborative airport arrival planning. *Transportation Science*, 37(4):422–433, 2003.

[9] S. Ayhan, J. Pesce, P. Comitz, G. Gerberick, and S. Bliesner. Predictive analytics with surveillance big data. In *Proceedings of the 1st ACM SIGSPATIAL International Workshop on Analytics for Big Geospatial Data*, pages 81–90, 2012.

[10] G. B. Chatterji and B. Sridhar. National airspace system delay estimation using weather weighted traffic counts. *AIAA Guidance, Navigation, and Control Conference and Exhibit*, 2005.

[11] J. Ding, J. Ji, and H. Wang. Optimization of airport flight arrival and departure based on compromise immune algorithm. In *Proceedings of the Third International Conference on Natural Computation*, pages 677–681, 2007.

[12] E. P. Gilbo. Airport capacity: Representation, estimation, optimization. *Control Systems Technology, IEEE Transactions on*, 1(3):144–154, 1993.

[13] E. P. Gilbo. Optimizing airport capacity utilization in air traffic flow management subject to constraints at arrival and departure fixes. *Control Systems Technology, IEEE Transactions on*, 5(5):490–503, 1997.

[14] E. P. Gilbo. Arrival/departure capacity tradeoff optimization: a case study at the st. louis lambert international airport (stl). In *5th USA/Europe Air Traffic Management R&D Seminar*, 2003.

[15] T. R. Inniss and M. O. Ball. Estimating one-parameter airport arrival capacity distributions for air traffic flow management. *Air Traffic Control Quarterly*, 12(3):223–251, 2004.

[16] J. Krozel, B. Hoffman, S. Penny, and T. Butler. Optimization-based analysis of collaborative airport arrival planning. *AIAA Guidance, Navigation, and Control Conference and Exhibit*, 2003.

[17] V. Ramanujam and H. Balakrishnan. Estimation of arrival-departure capacity tradeoffs in multi-airport systems. In *Decision and Control, 2009 held jointly with the 2009 28th Chinese Control Conference. CDC/CCC 2009. Proceedings of the 48th IEEE Conference on*, pages 2534–2540, 2009.

[18] M. A. Stamatopoulos, K. G. Zografos, and A. R. Odoni. A decision support system for airport strategic planning. *Transportation Research Part C: Emerging Technologies*, 12(2):91–117, 2004.

Optimizing voice processing resources of the Trunk Gateways in NGN networks

Ali Balma
University of Tunis El Manar,
National Engineering School of Tunis
OASIS, B.P. 94, Rommana
1068, Tunis, Tunisia
Email: alibalma05@yahoo.fr

Atidel B. Hadj-Alouane
University of Tunis El Manar,
National Engineering School of Tunis
OASIS, B.P. 94, Rommana
1068, Tunis, Tunisia
Email: atidel.Hadj@enit.rnu.tn

Nejib Ben Hadj-Alouane
University of Tunis El Manar,
National Engineering School of Tunis
OASIS, B.P. 94, Rommana
1068, Tunis, Tunisia
Email:nejib_bha@yahoo.com

***Abstract*—In this paper, we address the problem of minimizing the use of voice processing resources of NGN equipments, the so called trunk gateways (TG), that transform the TDM traffic of legacy network into IP packets. We develop an Integer Linear Program (ILP) and add valid inequalities in order to strengthen its linear relaxation, tighten the lower bound and break the symmetry that causes the branch-and-bound algorithm to perform poorly. In addition, we consider survivability constraints when a given TG fails. The computational results conducted on randomly generated data for network size ranging from 50 to 70 nodes, show the efficiency of the added valid inequalities.**

I. Introduction

Almost all the telecommunication operators adopted the Next Generation Network (NGN) architecture worldwide. They installed NGN networks to deliver packet based services, such as VoIP, as well as the legacy circuit switching based services, namely the Time Division Multiplexing (TDM). The NGN concept is promoted by the standardization body, International Telecommunication Union, to the operators as an integrated platform that aims to reduce Capital Expenditure (CAPEX) and Operations Expenditure (OPEX). In fact, in the TDM networks, each service has had its own network and operating human and organizational structure causing CAPEX and OPEX to increase tremendously.

The most of the operators migrate their legacy network towards NGN smoothly in an evolutionary manner. But the migration process may take a long period depending on the sparsity and the size of the legacy network and the number of the subscribers. Consequently, the NGN and TDM equipments have to coexist and interwork along the migration process (see figure 1). As detailed by ITU in [4], the NGN architecture is composed essentially of four layers that interact via open and standardized interfaces. The access layer is materialized by the TDM exchanges. The transport layer is assured by an IP network composed of carrier class routers. The TG are at the frontier between the access layer and the transport layer. They are in charge of transforming the communications into IP packets when they take place between exchanges connected to different TG. In this case, the voice processing (VP) resources in the corresponding TG are reserved and the IP packets are transferred through Real Time Protocol. As for the communications between exchanges behind the same TG, no IP conversion is needed and the voice processing resources are not used.

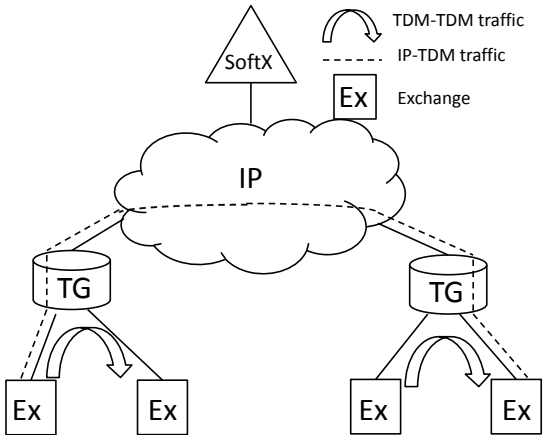


Fig. 1. NGN network connecting legacy TDM exchanges.

The call control layer, represented here by the Soft switch (SoftX), handles the calls and controls the TG in order to connect callers and callees through appropriate signaling protocols, essentially Sigtran and H.248 protocols. (See [12], [5], [4], [16] for further technical details). Finally, the application layer situated at the top, assure the delivery of particular services, besides the voice calls. This layer is not represented in the figure as it is beyond the scope of the present paper.

Actually, each TDM exchange is connected to at least two TG through two trunks for survivability purposes. One trunk is active and the second one is in a standby status. If a TG fails, then the traffic is switched from the active trunk over the standby trunk in order to avoid service disruption.

The VP resources are stored in specific boards that have important costs. Besides, the IP adaptation process induces some delay and may have an impact on the quality of service (QoS) requirements. These VP resources are used when the communications take place between TDM exchanges that are connected to different TG. But when the communications are between exchanges linked to the same TG, there is no need for IP transformation and the VP resources are saved (the so called Hairpin connection).

Therefore, we aim to find a TDM exchanges assignment to the TG that minimizes the use of VP resources of the TG. Moreover, we must take into account the survivability aspect; that is, how to reassign the exchanges to the remaining TG when a given TG fails.

The present paper is organized as follows. In the next section we present a survey on the previous works undertaken in the same field. In the section III, we give a mathematical formulation with an Integer Linear Program (ILP) and provide some valid inequalities that strengthen the formulation, tighten its lower bound and break its symmetry. In the section IV, we address the survivability issues when a TG fails. We present computational experiments in the section V and finally we conclude.

II. Literature survey

The NGN concept has been extensively studied in the recent years and many papers gave the details of its structure and how it interworks with legacy TDM networks[9], [5], [2], [14], [4]. Most work developed about NGN has concerned the process of migration from classical TDM technology towards NGN architecture. The authors in [8], [12], [13], [15], [10], [11], [14], [9], [17] distinguished three migration processes:

- upgrading the existing TDM equipments to support IP packet switching technology instead of circuit switching,
- replacing the TDM network by NGN equipment and IP transport network in an overnight process,
- overlay process where TDM equipments are gradually replaced by NGN equipments and the two technologies interwork for a long period of time (some years)

The authors of [9], [8], showed that the overnight process is cost effective for medium size and large networks. In [15], the authors considered the minimization of IP-TDM conversion by developing an analytic model based on stochastic process. In [9], a study about an overnight migration process was given for Iceland with a linear programming model, but the authors did not give the model in details. In addition, they addressed an overnight process where the network was of small size (10 nodes).

To the best of our knowledge, no previous work was realized about optimizing the VP resources by linear programming methods. In this paper we consider the optimization, at an operational level for overlay process where NGN and TDM equipments coexist and interwork for a long period. We aim to minimize the IP-TDM transformation by a linear programming based study.

III. Problem formulation

We assume given a set of exchanges I which elements i must be connected to a set of TG denoted by H. Generally, the network composed of exchanges is divided into areas, each one containing one TG and an approximately equal number of exchanges. Each exchange can be connected to two TG taking into account geographical proximity. We denote by H_i the subset of H which elements are TG to which the exchange i cab be connected. We equally allocate exchanges to the TG; that is, $|H_i| = |H_j|, \forall i \neq j$.

We aim to find a mapping of the exchanges on the TG that minimizes the IP transformation on the TG. For that purpose, we consider the objective of minimizing the overall IP traffic between the TG. By achieving that objective, we minimize at the same time the IP conversion in the TG, exploiting the Hairpin connections, and reduce the use of VP resources.

The problem, as described above, can be seen as a variant of the well-known hub location problem [1], [3]. Thus, the decision variables are the following:

- x_i^h that takes 1 if the exchange $i \in I$ is connected to the TG $h \in H$, and takes 0 otherwise,
- v^{hk} is the volume of the IP traffic going from TG $h \in H$ to TG $k \in H$.

With these data and notations, the formulation of the ILP can be written as follows:

$$\min \sum_{h \in H} \sum_{k \in H} v^{hk} \tag{1}$$

subject to

$$\sum_{h \in H_i} x_i^h = 1 \quad \forall i \in I, \tag{2}$$

$$\sum_{i \in I} \sum_{j \in I} x_i^h . x_j^k . d_{ij} = v^{hk} \quad \forall (h,k) \in H^2, \tag{3}$$

$$x_i^h \in \{0,1\} \quad \forall i \in I, \forall h \in H,$$

$$b^{hk} \text{ integer}, \quad \forall (h,k) \in H^2,$$

The objective function (1) aims to minimize the total IP traffic circulating in the IP transport network. The constraint (2) stipulates that any exchange can be assigned to only one TG. The constraints (3) impose that the volume of communications transformed into IP packets and transported through the IP network is effectively handled by the VP resources contained in the TG.

The above mathematical program is not linear due to the constraints (3). For making it linear, we introduce new decision variables y_{ij}^{hk} that take 1 if i and j are assigned respectively to the TG h and k. Hence, we have the following inequality:

$$x_i^h + x_j^k \leq y_{ij}^{hk} + 1, \forall (i,j) \in I^2, \forall (h,k) \in H^2. \tag{4}$$

Consequently the constraint (3) becomes

$$\sum_{i \in I} \sum_{j \in I} y_{ij}^{hk} . d_{ij} = v^{hk} \quad \forall (h,k) \in Hi^2, \tag{5}$$

In addition, we must append to the model the logical constraint (4) and the fact that the new variables y_{ij}^{hk} must be binary.

The new formulation has $|I|.|H|+|H|^2+|I|^2.|H|^2$ variables and $|H|^2 + |I|.|H| + |I|$ constraints. This ILP is known to be NP-hard as it can be seen as a variant of the Hub Location problem, which is known of being NP-hard [3]. Besides, it is a compact formulation that may cause the branch-and-bound algorithm to perform poorly [7]. Indeed, it

has an important symmetry that makes the branch-and-bound algorithm examine many solutions that have the same value of the objective function. In addition, the linear relaxation of this ILP provides a very weak lower bound.

In order to strengthen the previous formulation, we propose to add valid inequalities, satisfied by any integer solution, but that will cut away many noninteger solutions, obtaining thus a better representation of the feasible region. Adding valid inequalities is a widely used technique to strengthen formulation and accelerate the exact resolution of difficult problems [6].

For that purpose, we devise the following valid inequalities.

A. TG flow conservation inequalities

All the demand traffic issued by exchanges i connected to a given TG h go to the exchanges j behind the same TG h and the rest is transferred to those connected to different TG k. When the destination exchanges are connected to $k \neq h$, the demand traffic is transformed into IP packets and must traverse the IP network.

Hence, we have

$$\sum_{i \in I} x_i^h.(\sum_{j \in I} d_{ij}) = \sum_{j \in I} \sum_{i \in I} x_i^h.x_j^h.d_{ij} + \sum_{k \in H} v^{hk}, \forall (h,k) \in H^2 \quad (6)$$

We can linearize the nonlinear term of the right hand side of this equation as we did for the set of constraints (3), but this transformation would give a form of constraints that does not allow to take advantage of the zero-half cuts. Indeed, the many computational tests conducted point out the efficiency of the zero-half cuts applied by Cplex for this formulation that accelerate tremendously the exact resolution of the problem. In order to keep this advantage, we simply eliminate the nonlinear term from the right hand side of the equation (6) and transform it into inequality, as follows

$$\sum_{i \in I} x_i^h.(\sum_{j \in I} d_{ij}) \geq \sum_{k \in H} v^{hk}, \forall (h,k) \in H^2, \quad (7)$$

B. Assignment constraints

Since each exchange must be connected to only one TG, then a given pair of exchanges $(i,j) \in I^2$ is connected to only one pair of TG $(h,k) \in H^2$. Indeed, if $x_i^h = 1$ and $x_j^k = 1$, then $y_{ij}^{hk}) = 1$ for (h,k) and takes 0 for the other pairs of TG. This fact can be represented by

$$\sum_{h \in H} \sum_{k \in H} y_{ij}^{hk} = 1, \forall (i,j) \in I^2, \quad (8)$$

This new constraint accelerates dramatically the exact resolution of the problem and strengthens the previous formulation.

IV. Survivability considerations

In the normal situation all the TG are working normally. A given TG may go down due to possible major hardware failure. The traffic issued by/arriving to the exchanges connected to this TG are interrupted. For avoiding the traffic disruption, the second TG will play the survivability role. Indeed, the trunk with one TG is a working link and the second trunk for the other TG is a standby link. When a TG fails, then the traffic is immediately switched over to the standby link.

The failure situation differs from the normal situation by the fact that the new mapping of the exchanges to the TG, consequent to the switching over, is not optimal. If the failure situation may take a long time because of long lasting repair operations, a new mapping of the exchanges on the TG can be rapidly found in order to find the minimum IP conversion for the failure situation.

Let us consider a TG failure relative to a given $\bar{h}$. Then we fix all the variables $x_i^{\bar{h}}$ to zero. Also, the variables $y_{ij}^{\bar{h}k}$ are fixed to zero. This variable fixing constraint added to the previous formulation for the failure situation, speeds up the running time and provides rapidly an optimal solution relative to the TG $\bar{h}$ failure situation. It breaks the symmetry of the problem and allows for rapid resolution times, as confirmed by the computational experiments in the next section. After the recovery of the TG $\bar{h}$, we can roll back and restore the working links with the assignment of exchanges to the TG of the normal situation.

From a practical point of view, we prepare an assignment plan for each TG failure case. It consists of determining what working trunks should be switched over standby trunks. The swap operation is simply done by blocking the signalling links between exchanges and TG. This can be done by a batch of commands executed through a network management system on each TG.

V. Preliminary results

All the computational experiments were conducted with the OPL/Cplex 12.2 package on a Dell machine that has Intel Xeon 3,3 GHz CPU and 8 Gb of RAM. We set running time limit to 15 hours. We considered a network with $|H| = 5$ and the number of exchanges $|I| = 50$, 60 and 70, as beyond 70, Cplex was not able to find optimal solution within the set time limit.

For the amount of demand traffic d_{ij}, we generate random values for each pair of exchanges ($|I|.(|I| - 1)/2$ pairs) between 3 and 15.

We conducted two sets of experiments:

- the first set of tests aim to solve exactly the instances for the normal situation.
- the second set of tests is relative to the failure situation.

A. Results for the normal situation

Table I reports the computational results relative to the normal situation. We present the instances with number of exchanges $I = 50$, 60 and 70. For each value of $|I|$, we run 3 instances. Beyond 70 exchanges, Cplex did not return the optimal solution. The table gives the value of the optimal solution S in Mb/s and the running time T in seconds.

B. Results for the failure situation

Tables II, III and IV present the computational results relative to the situation when when a given TG $\bar{h}$, fails for,

$\|I\|$	S	T
50	7830	234
	7726	262
	7894	297
60	11143	2600
	11305	1340
	11246	1919
70	15489	14346
	15599	24465
	15436	7720

TABLE I
COMPUTATIONAL RESULTS FOR THE NORMAL SITUATION

S	h	$S_{\bar{h}}$	$T_{\bar{h}}$	$G_{\bar{h}}$
7830	1	7830	5,9	0
	2	7875	7,1	0,6
	3	7830	7,3	0
	4	7894	8,8	0,8
	5	7830	7,3	0
7726	1	7726	5,8	0
	2	7810	6,0	1,1
	3	7726	5,8	0
	4	7798	8,1	0,9
	5	7726	7,3	0
7894	1	7959	7,7	0,8
	2	7894	6,9	0
	3	7950	7,2	0,7
	4	7894	7,5	0
	5	7894	6,8	0

TABLE II
COMPUTATIONAL RESULTS FOR THE FAILURE SITUATION WITH $|I| = 50$

respectively $|I| = 50$, 60 and 70 nodes. For each instance, related to $\bar{h}$, we give the value of the solution $S_{\bar{h}}$ in Mb/s, the running time $T_{\bar{h}}$ in seconds and the gap $G_{\bar{h}}$, in %, between the optimal solution of the normal situation and that relative to the failure situation. It is calculated by $G_{\bar{h}} = \frac{S_{\bar{h}} - S}{S_{\bar{h}}}$

The results show that the optimal solutions are rapidly obtained, compared to the normal situation. Moreover, the values of the optimal solutions are very close to those of the normal situation. Indeed, the gap between these two solutions did not exceed 0,5% for all the instances. The instances appear more comforting compared to the normal situation. This is due

S	h	$S_{\bar{h}}$	$T_{\bar{h}}$	$G_{\bar{h}}$
11143	1	11143	12,5	0
	2	11201	12,1	0,5
	3	11143	12,5	0
	4	11220	12,2	0,7
	5	11143	12,1	0
11305	1	11305	12,5	0
	2	11406	14,5	0,9
	3	11305	12,4	0
	4	11305	11,0	0
	5	11327	7,3	0,2
11246	1	11300	12,3	0,5
	2	11246	13,5	0
	3	11255	11,8	0,1
	4	11246	11,8,5	0
	5	11246	12,9	0

TABLE III
COMPUTATIONAL RESULTS FOR THE FAILURE SITUATION WITH $|I| = 60$

S	h	$S_{\bar{h}}$	$T_{\bar{h}}$	$G_{\bar{h}}$
15489	1	15489	22,4	0
	2	15500	22,7	0
	3	15489	24,5	0
	4	15489	18,7	0
	5	15559	23,2	0,5
15599	1	15633	23,8	0,2
	2	15599	23,7	0
	3	15599	21,9	0
	4	15648	21,3	0,3
	5	15599	18,7	0
15436	1	15436	22,7	0
	2	15487	13,5	0,3
	3	15436	24,6	0
	4	15436	22,7	0
	5	15469	21,0	0,2

TABLE IV
COMPUTATIONAL RESULTS FOR THE FAILURE SITUATION WITH $|I| = 70$

to the variable fixing to zero, namely $x_i^{\bar{h}}$ and $y_{ij}^{\bar{h}k}$. This breaks the symmetry of the problem and reduces its complexity, since many variables are fixed.

VI. CONCLUSION

In the present paper, we addressed the problem of minimizing the use of VP resources of the TG by assigning TDM exchanges to the appropriate TG. Such an assignment allows for using Hairpin connections where the IP conversion is not needed, when communications take place behind the same TG.

For that purpose, we developed an Integer Linear Program based on a compact formulation. It turned out to be difficult to solve exactly due to its symmetry and the weakness of its lower bound. Hence, we devised valid inequalities that strengthened the previous formulation and tightened its lower bound. Furthermore, we took into consideration the survivability constraints when a TG fails by reoptimizing the problem after fixing variables related to the failing TG.

The computational experiments showed the efficiency of the valid inequalities added, allowing to solve exactly the problem up to 70 nodes. These results are encouraging to explore an approach of breaking the symmetry of the problem. Our ongoing work is focusing on finding another formulation that permits a finer representation of the feasible solutions in order to develop more efficient valid inequalities and solve larger network sizes.

REFERENCES

[1] S. Alumur and B. Y. Kara, Network hub location problems: The state of the art, European Journal of Operational Research 190 (2008) 1–21.

[2] S. Maniatis, E. Nikolouzou and I. S. Venieris, Dynamic resource management for QoS provisioning over next-generation IP-based wireless networks, Computer Communications 29 (2006) 730–740.

[3] I. Contreras and E. Fernandez, General network design: A unified view of combined location and network design problems, European journal of Operational Research 219 (2012) 680–697.

[4] ITU, Series Y: Global information infrastructure, Internet protocol aspects and next-generation networks: Next Generation Networks Frameworks and functional architecture models. General overview of NGN, ITU-T Recommendation Y.2001 (2004).

[5] J. Schroder, M. Gotzer, R. Muller, Resource management in next generation networks, Int. J. Electron. Commun. (AEU) 60 (2006) 116–124.

[6] L. A. Wolsey, Strong formulations for mixed integer programs: valid inequalities and extended formulations, Mathematical Programming 97 (2003) 423–447.
[7] C. Barnhart, E.L. Johnson, G.L. Nemhauser, M.W.F. Savelsbergh, and P.H. Vance, Branch-and- Price: Column Generation for Solving Huge Integer Programs, Operations Research, Vol. 46, No. 3, pp. 316-329, 1998.
[8] S. Paudel, Migration of TDM Network into NGN for the Fixed Wire-line Access Network, Proceedings of Internet IEEE (AH-ICI) (2011) 1–5.
[9] H. M. Sigurdsson, S. E. Thorsteinsson, T. K. Stidsen,*Cost Optimization Methods in the Design of Next Generation Networks*, IEEE Communications Magazine, September 2004, pp. 118–122.
[10] C. Ghazel and L. Sadane, Migration from Traditional Networks to Converged Next Generation Networks Architecture with Guaranteed Quality of Service, Proceedings of International Conference on Convergence and Hybrid Information Technology (2008) 417–424.
[11] N. Kryvinska, C. Strauss, Next Generation Service Delivery Networks: a Strategic Approach Involving Architectural Planning and Design, from a Business Perspective, Proceedings of Fifth Advanced International Conference on Telecommunications (2009) 410–415.
[12] A. Amer, Design and Capacity Planning of Next Generation Network (NGN), Proceedings of the Mosharaka International Conference on Communications, Signals and Coding, MIC-CSC '08 (2008) 28–34.
[13] A. A. Almughaless, A. M. Alsaih, Optimum Migration Scenario From PSTN to NGN, Proceedings of the Second International Conference on Communication Systems, Networks and Applications ICCSNA 1 (2010) 227–231.
[14] S. Cakaj, M. Shefkiu, Migration from PSTN to NGN, Proceedings of ELMAR (2007) 183–186.
[15] H Li, H. Lin, H. Lee and P. Das, Optimizing the Cost of Migration from Wireless TDM Networks to Next Generation Packet Networks, Proceedings of 2008 International Symposium on a World of Wireless, Mobile and Multimedia Networks (2008) 1–8.
[16] S. Karapantazis, F. PavlidouVoIP, A comprehensive survey on a promising technology, Computer Networks 53 (2009) 2050–2090.
[17] P. Podhradsky, Migration scenarios and convergence processes towards NGN (present state and future trends). Proceedings 46th International Symposium Elmar (2004) 39–46 .

Web-oriented tools to allow automatic communication between private and public components in the field of milk production in North- eastern, Italy

Grazia MANCA
Istituto Zooprofilattico Sperimentale delle Venezie
Legnaro (PD), 35020, Italy

and

Antonia RICCI
Istituto Zooprofilattico Sperimentale delle Venezie
Legnaro (PD), 35020, Italy

and

Michele Brichese
Unità di Progetto Veterinaria - Regione Veneto
Dorsoduro 3493 Venezia (VE), 30123, Italy

and

Stefano MARANGON
Istituto Zooprofilattico Sperimentale delle Venezie
Legnaro (PD), 35020, Italy

ABSTRACT

In the context of a European internal market, free movement of animals and their products has to be allowed. The first step for ensuring that is for all Member State to respect common sanitary constraints and apply monitoring actions to maintain the required standards. [1] In this framework producers have the prime responsibility for compliance with the requirements provided by law along the whole food production chain and the competent authorities of each Member State have to monitor the application of this principle of own check. [2]
Moreover, in order to make evidence of the efforts and the results obtained, and to guarantee traceability and transparency of animal productions to consumers, the use of information systems to collect and exchange data is strategic. [3, 4, 5]

The aim of this paper is to describe a practical use of the information system technologies applied in the field of milk production. It also wants to describe a concerted and collaborative approach between public and private components to the monitoring and control actions in dairy farms of the Veneto Region (Northern Italy).
Since 1998, in accordance with Regulation (EC) N. 853/2004 (replacing Directive EC 92/46 and D.P.R. 54/97), a milk safety program has been active in the framework of the regional health information system (RIS), dedicated to the management of analyses performed as own checks by accredited laboratories on behalf of dairy farmers. The first aim was to control the sanitary status of raw milk at the farm level, both involving private and public components and providing all the actors of the production chain with full access to data. This system has its foundation in the Regional Data Bank (RDB) of breeding and related industries, officially recognised nationwide with DM 31/01/2002.
RDB, managed by the public Veterinary Services, is the official information node, which contains personal and juridical data on farmers and dairies and allows both private and public institutions to unequivocally identify any monitored subject.

Through a web page (www.lattecrev.it), private laboratories upload files to the system regarding the analyses performed as own checks on raw milk supplied to dairies for sale. The system itself returns information in real-time on dairy farmers that remain within the parameters originally provided by DPR 54/97, now repealed and replaced by EC Reg 853/04.
Meanwhile, the Veterinary Services of the 21 Local Public Health Units (LPHUs), acting as health authorities in the region, feed RDB archives with data of the official controls performed on dairy farms and dairies.
Furthermore, a specific procedure called GESVET, interfaced with RDB, was introduced in 2007 for the management of the activities performed by the Veterinary Services: thanks to this procedure in 2008 the Veneto Region started the registration (Reg. EC 852/2004) of the farms that apply for authorization to directly sell raw milk through automatic vending machines. The system allows the display of distributors related to each dairy company in order to ensure traceability in the production chain in the case of adverse health events.
An important node of the RIS is the Istituto Zooprofilattico Sperimentale delle Venezie (IZSVe), a veterinary public health institute that conducts official laboratory controls and research activities in the areas of animal health and welfare, food safety, and environmental protection. The IZSVe is also responsible for the implementation and management of all the mentioned systems.

Keywords: dairies, veterinary, milk, data management, network system, web services

REGIONAL MILK PRODUCTION AND THE SANITARY REGIONAL NETWORK

In the Veneto Region there are 4,023 dairy farmers (RDB) primarily dedicated to raw milk production: in 2012, they produced 1,105,454 tonnes of raw milk, accounting for 10.2% of the national data (updated to December 31st 2012 - http://www.clal.it).

Considering its traditionally important role in cattle and milk production, in 1998, the Veneto Region purposed the idea of a network, using web-oriented systems, of all the subjects involved in the milk production chain. Such network is based on the provisions of Directive 97/12 EC about the establishment of surveillance networks in the field of animal health and food safety, and those of Directive 46/97 EC, regarding the implementation and management of monitoring plans in milk farms and laying down the sanitary standards required for raw milk. [2, 3]

The project of implementing a regional Data Bank of bovine herds fed by the Veterinary Services of the LPHUs had started only a few years earlier, as the first step for the recording of data about cattle production and activities performed by the public authority in the sanitary field. Since then, the architecture and technology used have evolved considerably, both to meet the needs of the system's users and to comply with the legal requirements established over the years.

In the late 1990's a first system was implemented, with the publication of a web page to which the private Laboratories uploaded data about dairy farmers and the analyses performed on the raw milk produced. The Veterinary Services of the LPHUs could display these data and feed information about the compliance of analysis results with the sanitary standards required by law.

One of the most relevant problems of this starting period was the correct and unequivocal identification of each subject across the different archives.

In order to solve this serious difficulty, and recognizing the importance of stronger cooperation, in 2003, the local producer associations agreed to interface their archives of milk producers with the RDB of breeding farmers.

The information system was rewritten, and the two different archives of personal data were combined and uploaded to RDB, so ensuring that each farmer who supplies raw milk in the Veneto Region is indentified with a unique code.

The system was recently modified in order to comply with the provisions of EC Reg. 853/04, which, among other things, state that the producer is fully responsible for guaranteeing the sanitary and production quality of the end-product [4]. They also state that the producer, identified with the dairy level in the milk production chain, has responsibility for alerting the farmers if an adverse result emerges from the analyses performed on the milk collected at the farm level, in order to ensure the swift implementation of corrective actions.

For this reason new functionalities have been implemented in the system in order to allow better data availability and consultation by the private components. A function was also introduced for printing the non-conformity notifications from the diaries. The LPHUs can monitor if the alert communications are promptly conducted by producers.

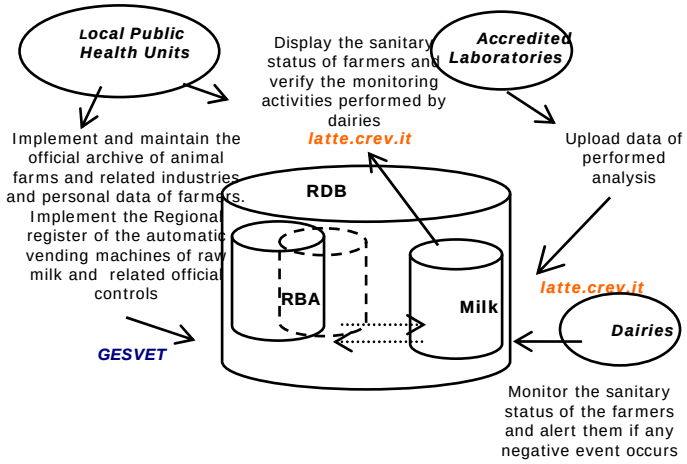
Table 1 provides a concise list of the actors of the system and their role.

Table 1 – The actors of the milk information system and related activities in the management of the monitoring plans

LPHUs	As they represent the official authority, they are the owner of the Local Data Bank of farmers and related industries and they guarantee its integrity through ongoing validation. They verify the monitoring actions performed by milk producers as own checks.
Farmers	They have to guarantee milk sanitary and production standards at the farm level, as required by law. They can delegate dairies, to which they supply raw milk, to apply the own-check monitoring plan.
Dairies	They are responsible for guaranteeing the EC standard of raw milk production. They have to implement monitoring actions along the whole production chain.
Accredited laboratories	They are the authorized laboratories for performing analyses on raw milk samples collected at the farm level. They daily upload the analyses performed and their results to the Regional milk system.
IZSVe	It is the Institute that implemented and manages the information system. It performs data validation and extraction to provide the information requested to regional authorities and other public administration, as the Regional body responsible for managing community funding in the agriculture sector.

As previously mentioned, the activation of computerized data collection systems and automated flows between the various entities involved is the prerequisite for the implementation of epidemiological surveillance networks, as provided for by legislation on animal health and food hygiene [1, 4, 5].

Figure 1 - The data flows of the System



THE DATA FLOWS

This is a description of data flows, as shown in Figure 1 above.
Each farmer has to collect raw milk samples as part of their own-checks for the evaluation of quality and sanitary parameters. This activity is usually performed by dairies, which guarantee the standard of the whole milk production chain. The analyses are carried out by private accredited laboratories, which daily upload files with the analysis results to the regional web page (www.crev.latte.it). The farmers are unequivocally identified by a unique code registered both in dairies and LPHUs databanks. The information node that allows data flows from private laboratories to public Veterinary Services and vice versa is RDB, the official archive of juridical and personal data of any monitored subject. Any private dairy or laboratory can download data about its farmers from RDB to check any possible mistake or difference between the official data and local archives.
Data sets related to dairy farms and analyses are collected and evaluated by the regional milk safety system: at this step analyses are processed by a specific software that, using statistical methods, provides the list of farms that have or have not respected the sanitary standards required by law.
After verifying the sanitary status of their farmers on the web, dairies have to inform them if the law parameters are not respected. The system allows printing the notifications of "non conformity status" for the farmers. Veterinary Services of the LPHUs can display the notifications sent by the dairies, so ensuring that all the corrective actions are promptly implemented.
Finally the regional Register Office provides LPHUs veterinary services and dairies with information on dairy farms and their sanitary status, and the results of raw milk analyses performed as own-checks.
LPHUs maintain the register (Reg. EC 852/2004) of the farms that have applied for authorization to directly sell raw milk through automatic vending machines and of the official controls performed by the Veterinary services, recording data through GESVET, a specific procedure interfaced with RDB archives.

THE TECHNICAL CARACTERISTIC

The systems built today are all based on Internet technologies (HTTP, SOAP, XML, Web Services) with a strong logic of integration (common master data). All systems are accessed with authentication, which ensures safe transactions on the database. Several access privileges are available: single consultation, writing, detailed editing and updating of data. The application, called LATTE.CREV, was implemented in Java (strong and portable object-oriented language) and is hosted on the servers of the Veneto Region, where the DBMS resides (Oracle©9i) along with the RDB, in which milk supplies are recorded. The Web Server used is Tomcat ©, the latest open source software (Apache© Software Foundation), which is responsible for managing client requests and forms the execution of Java modules.
GESVET is a client-server program based on web services technology, developed in Delphi7 and designed according to the HTTP / SOAP / XML standard, resident on Web server Apache 2.2.8 and Windows 2003. The databases are built on Oracle platform.

CONCLUSIONS

The gradual consolidation of the RIS, through the development of integrated procedures, allowed the complete mapping of the process for the production of cow's milk, including direct sale through the vending machines, which were only recently introduced in our territory. It also improved the quality of regional archives, through a constant validation of recorded data and the integration of public and private actors. It is an example of a public information system open to the production chain, where transparent data are made fully available to the private accredited laboratories and dairies. Moreover, the "just in time" availability of information, which can be accessed on the web, has encouraged the quality of data collected by the private components, by providing the Veterinary Services of LPHUs with a useful instrument for the traceability of products and giving the basis for the establishment of an epidemiological surveillance network and the appropriate governance of the raw milk chain production.
As many as 3,463 dairy farmers are currently monitored by the system, 117 of which with officially registered raw milk distributors.
The system also guarantees that the information needs of all the stakeholders (farmers, dairies, food business operators, producer associations) are taken into account and that the requests received from other entities or administrations are promptly met. For instance, this system represents today the official information base for the Regional Agriculture Department, and particularly for the Regional body responsible for European funding distribution. One of the conditions for access to European funds by the farmers is their registration on the regional system as evidence of their compliance with European sanitary standards for raw milk as required by Reg. EC nr. 853/04.

BIBLIOGRAPHY

1. *Council Directive 97/12/EC of 17 March 1997 amending and updating Directive 64/432/EEC on health problems affecting intra-Community trade in bovine animals and swine*
2. *Council Directive 92/46/EEC of 16 June 1992 laying down the health rules for the production and placing on the market of raw milk, heat-treated milk and milk-based products*
3. *Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety*
4. *Regulation (EC) No 853/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific hygiene rules for food of animal origin*
5. *Regulation (EC) No 854/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific rules for the organisation of official controls on products of animal origin intended for human consumption*

Comparing a Real-Life WSN Platform Small Network and its OPNET Modeler model using Hypothesis Testing

Gilbert E. PEREZ
Government Communications Systems Division, Harris Corporation
Melbourne, FL, USA gperez07@harris.com

and

Ivica KOSTANIC
Electrical and Computer Engineering Department, Florida Institute of Technology
Melbourne, FL, USA kostanic@fit.edu

ABSTRACT

To avoid the high cost and arduous effort usually associated with field analysis of Wireless Sensor Network (WSN), Modeling and Simulation (M&S) is used to predict the behavior and performance of the network. However, the simulation models utilized to imitate real life networks are often used for general purpose. Therefore, they are less likely to provide accurate predictions for different real life networks. In this paper, a comparison methodology based on hypothesis testing is proposed to evaluate and compare simulation output versus real-life network measurements. Performance related parameters such as traffic generation rates and goodput rates for a small WSN are considered. To execute the comparison methodology, a "Comparison Tool", composed of MATLAB scripts is developed and used. The comparison tool demonstrates the need for model verification and the analysis of good agreements between the simulation and empirical measurements.

Keywords: Wireless Sensor Network; Simulation; Modeling

1. INTRODUCTION

Modeling and Simulation (M&S) tools provide a comprehensive environment supporting the modeling and simulation of communication networks and distributed systems. Such tools include Riverbed's OPNET Modeler [1], QualNet [2], NS-2 [3] and emerging NS-3 [4]. These tools offer the capability to study the behavior and performance of the networks through model design, simulation, data collection and analysis. Hence, simulation models are needed to adequately represent the network or system being modeled. Although any one of the tools could have been used, the commercially available OPNET Modeler was chosen to have some benefits as described in 0-[7] and available to universities via Riverbed's OPNET University Programs [8]. The development of the model is an iterative process involving subject matter experts (SME). The goal of the process is to develop a model that represents the particular network components and their interactions. It behooves the modeler and the model user to frequently ask the imperative question: "How representative is my network model to the actual real-life network being modeled?"

Assuming the model is a good enough representation of the actual network, model simulations are performed as trade-off studies to evaluate performance evaluations. This assumption needs to be validated to put any trust in the outputs of the model and the performance evaluations. Hence, verification and validation (V&V) of the simulation model is necessitated, that is verification that the model was indeed coded correctly and validation that it produces valid results. As stated in [9], one of the key V&V principles stated in the Verification, Validation, and Accreditation Recommended Practices Guide (DMSO, 1996) is that "V&V is both an art and a science, requiring creativity and insight." Current simulation packages, offer a process for analyzing and designing communication networks, devices, protocols, and applications. System behaviors can be compared in regards to different technologies but not to real-life implementations of the network. In [10], a method is shown to establish statistical validity of discrete event simulations through running multi-seeded simulation runs, however, this is model statistical validity and a comparison to a real-life platform is still needed.

In order to avoid the high cost to run test and "what-if" scenarios on real-life network systems, model simulations of the real-life networks are executed. Subject Matter Experts (SME) are the primary decision makers in determining whether the model output is adequately representative of the expected output. With these simulation results being used to make system design and implementation decisions, it is imperative to ensure the simulation model itself is an adequate representation of the real-life network. This paper illustrates an automated methodology for comparison of the output results of a Small real-life WSN and its complimentary OPNET WSN model.

Organization of the paper
Section 2 contains an overview of the two environments used for evaluation of the output of simulation against real systems. In Section 3, the experiment scenario performed on the real system environment is explained and its results shown. Section 4 contains an overview of the simulation environment setup to model the scenario executed on the real system. In Section 5, the comparison methodology is described and Section 6 encompasses the results of the comparison methodology as produced by the "Comparison Tool". Section 7 contains the conclusions and the proposed follow-on work.

2. EXPERIMENTAL SETUP OVERVIEW

The experimental setup consists of three distinct yet connected realms: a Real-Life WSN Wireless Sensor Network Platform, a WSN OPNET Modeler Model and a comparison tool. The three areas are described and their relationships established as follows.

Real-Life WSN Wireless Sensor Network Platform
The Crossbow Starter Kit [11]-[17], provided by the Wireless Center of Excellence at FIT [18], contains all the components needed to deploy a basic wireless sensor network and is used to generate the real world data. The kit includes three sensor devices known as motes or nodes, and a server gateway to connect sensors to a management system. A Windows® Based User Interface (Development Environment) for remote analysis, monitoring and mote programming, is also included. The battery powered mote, the USB interfaced programming board (which can act as a sniffer or a base station) and the laptop running the development environment are shown in Fig. 1.

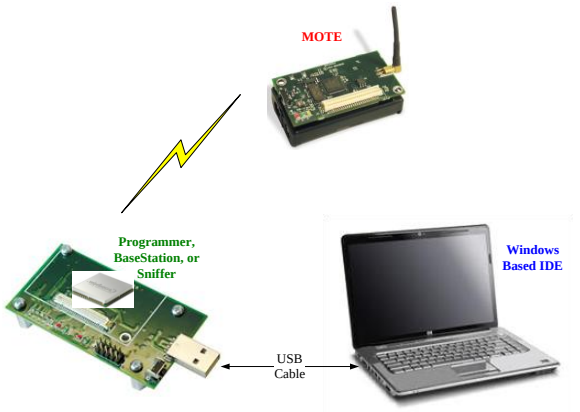


Fig. 1WSN Kit Components

Modeling and Simulation Tool
OPNET Modeler (Release 15.0.A PL3) provided by Riverbed under the OPNET University Programs [8], is the discrete event simulator used to simulate the WSN real-life platform. Although OPNET Modeler is capable of simulating all 7 layers of the Open Systems Interconnection (OSI) model, of particular interest are the application, network, MAC and physical layers. In general, the architecture of an OPNET model is structured in a hierarchical fashion from top to bottom into three domains: network, node and process. The network domain encompasses definition of the network model nodes and their interconnecting communication links. Geographical location of nodes and the communication mediums are also defined in the network domain. The node domain entails definition of how the developer implements the behavior of the specific node with respect to the 7 layers of the OSI and the data flow between the layers. Further definition of each OSI layer processing is captured in the process domain. Model and network statistics generation and implementation are part of the process domain.

WSN Model
The OPNET model of the motes, obtained from open-ZB web site [19] as an open source, is the starting point for simulating the real-life WSN platform.

Application Layer: The application layer of the OPNET Model provides the scenario builder with an option to control traffic generation patterns and attributes of the node and simulation.

Network Layer: The network layer of the OPNET model provides the scenario builder with an option to control the network layer attributes, hence defining the Zigbee network and its sizing for the node during the scenario. Packets from the application layer are encapsulated and propagated to the MAC layer. Packets from the MAC layer are de-encapsulated and propagated to the application layer.

3. THE EXPERIMENT

The experiment performed is described in this section. The rationale is to characterize the Small WSN Real-World Platform in order to model and form the basis of comparison.

Small Real-World WSN Platform
Fig. 2 is the small WSN network, consisting of a PAN Coordinator node and two Router nodes used to generate the "experimental data".

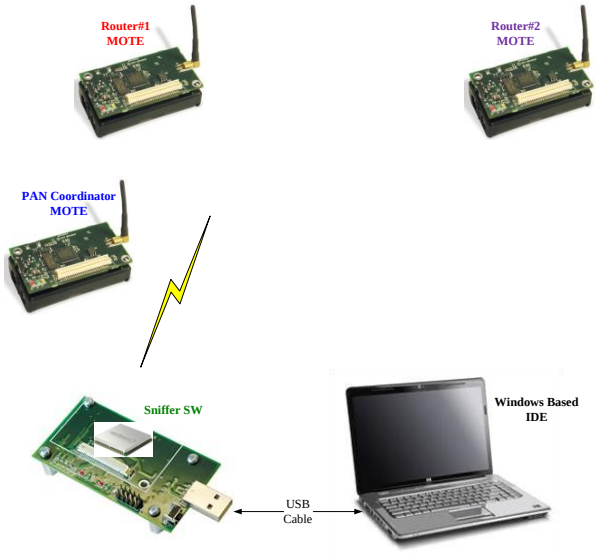


Fig. 2 Small Real-Life WSN Network Setup

The network scenario timeline is shown in Fig. 3. The Pan Coordinator runs for 2 mins (blue in the Network Startup Scenario Timeline) trying to setup the network. Router#1 starts to attempt to join the network at 2 mins into the scenario (red in the Network Startup Scenario Timeline). Router#2 joins the network at minute 7 of the scenario and runs for 10 mins (purple in the Network Scenario Timeline) Simultaneously the sniffer is running and capturing all traffic from the routers and coordinator for 17 mins (green in the Network Startup Scenario Timeline). This experiment is executed; saving the sniffer captured experimental data.

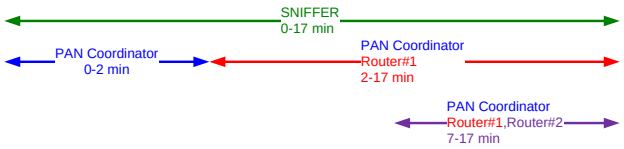


Fig. 3 Network Scenario Timeline

The Experiment Results
The Sniffer data is processed by the MATLAB scripts (part of the "Comparison Tool") yielding the traffic and its rates as shown in Table 1. The traffic rate statistics (transmission rate average and standard deviation) are used to generate the model traffic and used for comparison for model validation. Analysis of the Sniffer data yielded the WSN PAN Coordinator mote transmitting routing (Rte) messages approximately every 34 seconds. The WSN Router#1 mote joins the network 2 minutes

into the scenario and transmits its routing (Rte) messages approximately every 37 seconds. Router#1 also transmits is sensor information (DatUp) messages approximately every 4.3 seconds. In addition, the Router#1 transmits its health information (Hlth) messages approximately every 2 minutes. In the scenario at minute 7 Router#2 joins the network via Router#1 and Router#1 relays the sensor information (DatUp) messages from Router#2 to the PAN Coordinator approximately every 4.6 seconds.

TABLE 1 SMALL REAL-WORLD WSN PLATFORM TRAFFIC

PAN Coordinator Traffic 0-17 min			
Traffic Data Type	Message Size (Bytes)	Ave Duration between Transmissions Ts (ms)	Std Dev (Ts) Ts (ms)
Routing (Rte)	12/15	34223.750	436.026
Router#1 Traffic 2-17 min			
Traffic Data Type	Message Size (Bytes)	Ave Duration between Transmissions Ts (ms)	Std Dev (Ts) Ts (ms)
Router#1 Sensor (DatUp)	55	4305.580	285.125
Mote Health (Hlth)	29	119989.500	306.404
Routing (Rte)	12	37333.417	41.371
Router#2 Sensor (DatUp)	55	4558.279	1193.936

4. THE SIMULATION

The simulation performed is described in this section. The rationale is to model and simulate the Small WSN Real-World Platform and execute the "network scenario" in order to model and form a basis of comparison.

OPNET Model: Small WSN

The OPNET Model acquired from [19] was modified to generate the PAN Coordinator and Router traffic patterns as analyzed and captured in Table 1. The model statistic collection mode was set to collect all values mode, as opposed to sample mode, bucket mode or glitch mode. The small WSN model is executed long enough in duration to obtain at least 30 samples of the periodic traffic patterns. The simulation scenario was setup to mimic the Network Scenario Timeline in Fig. 3. The scenario runtime duration was selected to ensure that at least n > 30 samples are collected to deal with the large sample case in the test of means as described in [20]. A snapshot of the scenario data traffic settings for the model scenario is shown in Fig. 4.

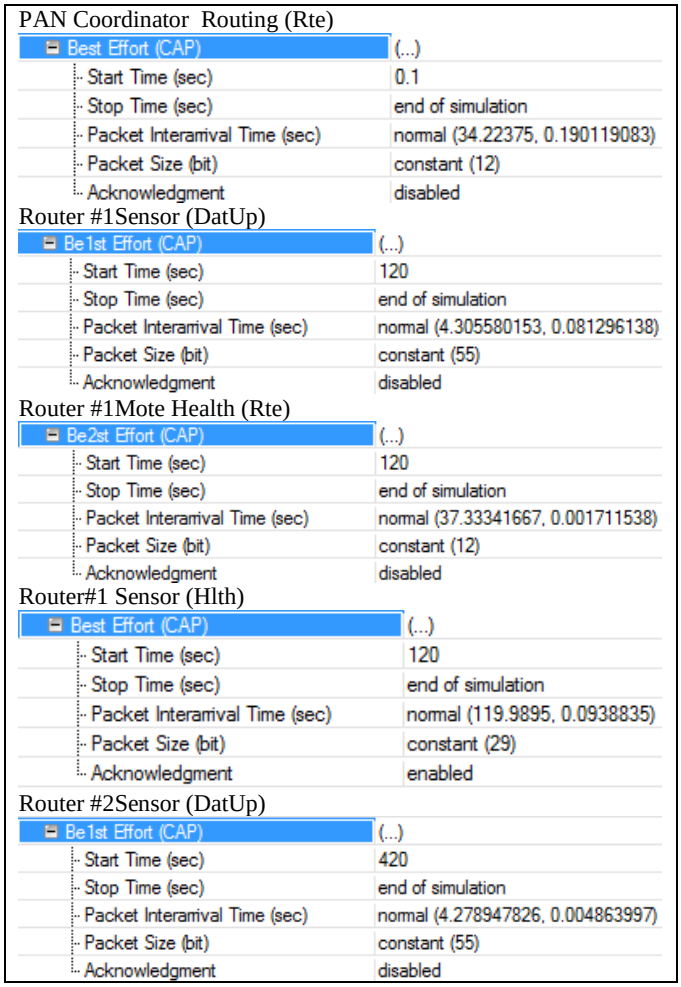


Fig. 4 Scenario data traffic settings

The Simulation Results

The OPNET Modeler data is processed by the MATLAB scripts as part of the "Comparison Tool" using the comparison methodology as described in the following.

5. THE COMPARISON METHODOLOGY

The comparison methodology is composed of the steps outlined in Table 2. In this paper, the process is illustrated for the traffic generation of the small WSN. The data generated by the Real-Life WSN Platform and the OPNET Model are the input to the "Comparison Tool" as shown in Fig. 5. The comparison tool is developed to implement the methodology allowing for repeatability and ease of use as discussed in [21]. The comparison methodology process is implemented in MATLAB [22] scripts.

TABLE 2 COMPARISON METHODOLOGY PROCESS

Comparison Methodology Process	
Step#	Description
1.	Instrument the Real-Life WSN Platform to generate the "experimental" data.
2.	Model the WSN to generate the "simulated" data.
3.	Run the Hypothesis Test Procedure of section 8.1 of [20] on the following: a) Two-Sample Test of Means (section 8.2.2) b) Two-Sample Test of Variance (section 8.3.2)
4.	Calculate and compare the Goodput *(ratio of the delivered amount of information in bits to the total delivery time)* for the Links Pan Coordinator ➔ Router#1 Router#1 ➔ Pan Coordinator Router#2 ➔ Router#1

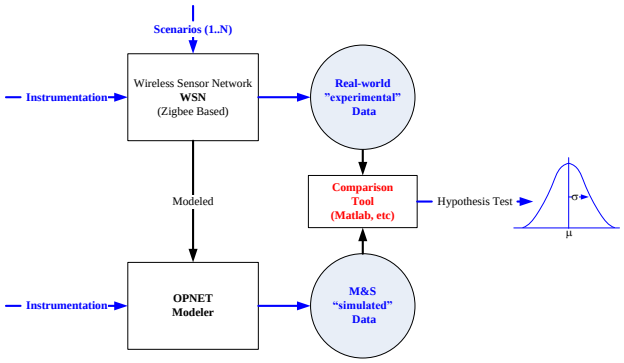


Fig. 5 Comparison Methodology Diagram

The "Comparator Tool" MATLAB scripts read the files containing the 'experimental' and 'simulated' data and executes the (Two-Sample Test of Means Algorithm) TABLE 3and (Two-Sample Test of Variance Algorithm) TABLE 4 Hypothesis tests. In addition, the "Comparator Tool" MATLAB scripts calculate the application level throughput (i.e. goodput) for the Pan Coordinator Mote and the Router Motes. The goodput is the ratio of the delivered amount of information in bits to the total delivery time in seconds as shown in Equation (1).

$$\text{Goodput} = \frac{\text{number of useful information bits}}{\text{total delivery time in seconds}} \quad \text{(bps)} \tag{1}$$

Furthermore, the goodput for the experimental and the simulation data (for the [Pan Coordinator ➔ Router#1], [Router#1 ➔ Pan Coordinator] & [Router#2➔Router#2] Links) are compared, yielding a percentage delta. The percent delta is calculated as shown in (2) and anticipated to be extremely low, if the simulation data does indeed compare well with the experimental data.

$$\text{Delta (\%)} = \frac{|\text{Exp\_Goodput(bps)} - \text{Sim\_Goodput(bps)}|}{\text{Exp\_Goodput(bps)}} \times 100\% \tag{2}$$

The comparison results are obtained graphically and shown in the following section.

TABLE 3 TWO-SAMPLE TEST OF MEANS ALGORITHM

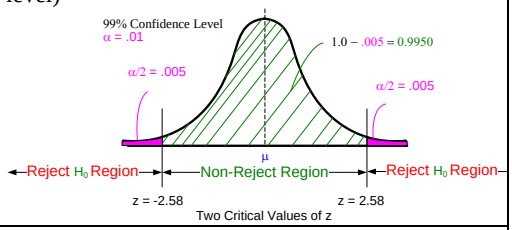
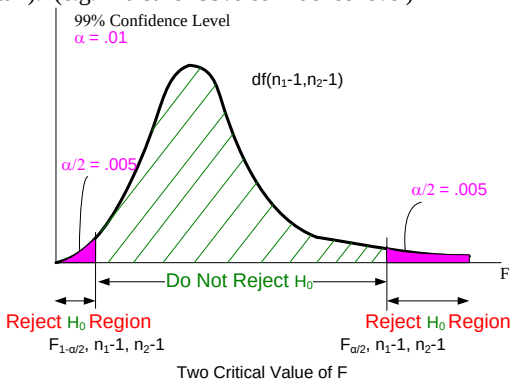
Two-Sample Test of Means	
Step#	Description
1.	State the Null H_0 & Alternative H_1 Hypothesis $H_0: (\mu_1 - \mu_2) = 0$ (The mean of experiment and simulated data are NOT different) $H_1: (\mu_1 - \mu_2) \neq 0$ (The mean of experiment and simulated data are different)
2.	Select the distribution to use: Since the sample sizes are ($n_1 \geq 30$), ($n_2 \geq 30$), both the samples are large. So, the sampling distribution of $\bar{x}_1 - \bar{x}_2$ is (approx or exactly) normal & we use the normal distrib to make the hypothesis test.
3.	Determine the rejection and non-rejection regions (from the Confidence Level, yielding the significance level α) The ≠ sign in the alternative hypothesis H_1, indicates that the test is Two –Tailed. The area in each tail of the normal distribution curve is α/2 Calculate the critical values of z for α/2 (area in each tail). (e.g. Normal dist for 99% confidence level) 
4.	Compute the value of the test statistic z for $\bar{x}_1 - \bar{x}_2$: $z = \frac{(\bar{x}_1 - \bar{x}_2) - \overset{0 \text{ from } H_o}{(\mu_1 - \mu_2)}}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$
5.	Plot the test statistic and make a decision to reject or not reject the null hypothesis H_0

TABLE 4 TWO-SAMPLE TEST OF VARIANCE ALGORITHM

Two-Sample Test of Variance	
Step#	Description
1.	State the Null H_0 & Alternative H_1 Hypothesis $H_0: (\sigma_1^2 - \sigma_2^2) = 0$ (The variance of experiment and simulated data are NOT different) $H_1: (\sigma_1^2 - \sigma_2^2) \neq 0$ (The variance of experiment and simulated data are different)
2.	Select the distribution to use: Since the sample sizes are ($n_1 \geq 30$), ($n_2 \geq 30$), both the samples are large. The sampling distribution of $(\sigma_1^2 - \sigma_2^2)$ is (approx or exactly) normal & we use the F distribution with $\nu_1 = n_1 - 1$ and $\nu_2 = n_2 - 1$ degrees of freedom to make the hypothesis test.
3.	Determine the rejection and non-rejection regions (from the Confidence Level, yielding the significance level α) The $\neq$ sign in the alternative hypothesis H_1, indicates that the test is Two –Tailed. The area in each tail of the F distribution with $\nu_1 = n_1 - 1$ and $\nu_2 = n_2 - 1$ degrees of freedom curve is $\alpha/2$ Calculate the critical value F for $\alpha/2$ (area in each tail). (e.g. F-dist for 99% confidence level)  Two Critical Value of F
4.	Compute the value of the test statistic F (ratio of the sample variances): $F = \frac{S_1^2}{S_2^2}$
5.	Plot the test statistic and make a decision to reject or not reject the null hypothesis H_0

6. THE COMPARISON METHODOLOGY RESULTS

What follows are the results from the "Comparison Tool" as described in the previous section.

Model Link Goodput Rates

Fig. 6 is the "Comparison Tool" graphical output result of comparing the Goodput Links:

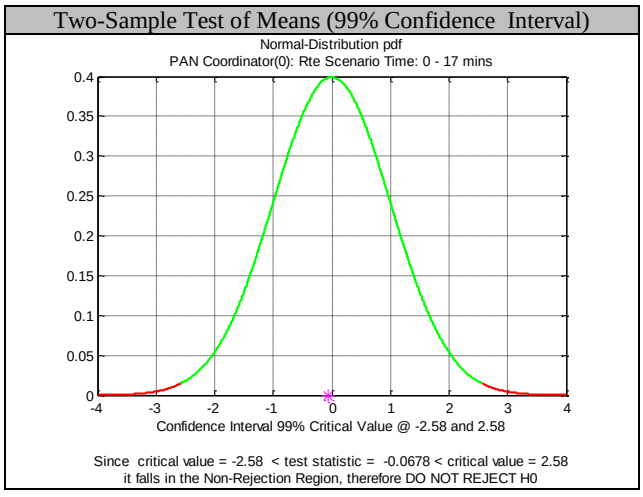
- Pan Coordinator ➔ Router#1
- Router#1 ➔ Pan Coordinator
- Router#2 ➔ Router#1

As can be seen, the Goodput rates for the Pan Coordinator only differs by 0.33% leading to an inference that the simulation data (Model links) goodput match the experimental data (Real-Life Platform Link). It can be seen that this is not the case for the Router goodputs and the simulation model needs further modification to match the Real-Life Platform.

Fig. 6 Link Rate Goodput Comparison Result

Model Traffic Rates

The output of the "Comparison Tool" is shown in Fig. 7 for the PAN Coordinator RTE Traffic (first line item, PN Coordinator Traffic, in Table 1) using the aforementioned Hypothesis test. The "reject" region is annotated in red, the "Fail to reject" region is annotated in green and the test statistic is annotated with a magenta asterisk. As can be seen from the plots (Hypothesis Test results), the experimental data and the simulated data appear to agree with a 99% Confidence Level. Similar results were obtained for the other traffic rates (Router#1 and Router#2 Traffic, in Table 1), yet were omitted due to lack of paper space. The "Comparison Tool" generates the graphs in a matter of seconds, providing the user the ability to see results quickly and confirm the reproducibility of real-life results in simulation as analyzed in [23],[24].



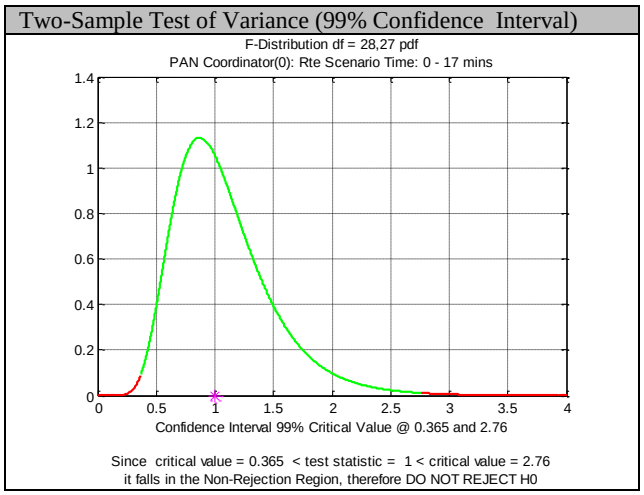


Fig. 7 Comparison Tool Output (PAN Coordinator RTE)

7. CONCLUSIONS AND FOLLOW-ON WORK

In the paper, hypothesis testing was used to evaluate the mean and variance of the traffic generation rate of a small wireless sensor network consisting of a PAN Coordinator node and two Router nodes. The comparison was done between the 'real world' experimental data generated from an instrumented real-life WSN platform and an OPNET Modeler model that generated the 'simulated' data. The comparison methodology consisted of running hypothesis testing, implemented via MATLAB scripts. The scripts, integrated into the "Comparison Tool" allow for repeatable tests to be performed.

The results show that with a 99% confidence level or level of significance of 0.01, the test statistic fails in the "fail to reject" or "Non-rejection region" and the null hypothesis that the means and variance between the real-life node and the model are indeed equal. The desired inference that follows is that the model of the small wireless sensor network is representative of the real-life platform as far as the traffic generation rates and the links goodput are concerned. This is in part a continuation of the work presented in [25].

In follow-on work, the "Comparison Tool" will be enhanced to compare the pathloss reported by the simulation model and the real-life WSN node. Further work will be in the direction of networks having increased complexity of architecture and node interaction. Performance parameter(s) such as End to End (ETE) delay and Packet Loss will also be considered.

8. REFERENCES

[1] Riverbed OPNET Modeler URL: http://www.riverbed.com/products-solutions/products/network-planning-simulation/Network-Simulation.html

[2] Qualnet URL: http://web.scalable-networks.com/content/qualnet

[3] NS-2 URL: http://nsnam.isi.edu/nsnam/index.php/User_Information

[4] NS-3 URL: http://www.nsnam.org/

[5] Korkalainen, Marko, et al. "Survey of wireless sensor networks simulation tools for demanding applications." Networking and Services, 2009. ICNS`09. Fifth International Conference on. IEEE, 2009

[6] Timm-Giel, Andreas, et al. "Comparative simulations of WSN." ICT-MobileSummit (2008)

[7] Marghescu, C., et al. "Simulation of a wireless sensor network using OPNET."Design and Technology in Electronic Packaging (SIITME), 2011 IEEE 17th International Symposium for. IEEE, 2011

[8] OPNET University Program: http://www.opnet.com/university_program/research_with_opnet/

[9] Love, G. and Back, G. (2000) "Model Verification and Validation for Rapidly Developed Simulation Models: Balancing Cost and Theory", Proceedings of the 18th International Conference of the System Dynamics Society, Bergen, Norway, August 6-10.

[10] "Verifying Statistical Validity of Discrete Event Simulations", OPNET Technologies, Inc. URL: http://www.opnet.com , White_Paper_from_OPNET\Verifying_Statistical_Validity_DES.pdf

[11] Crossbow® http://bullseye.xbow.com:81/industry_solutions/BuildingAutomation.aspx

[12] Crossbow Wireless Sensor Network Start Kit: WSN_START_Datasheet.pdf

[13] Crossbow Technology, May 2009, http://www.xbow.com

[14] TinyOS, May 2009, http://www.tinyos.net

[15] MICA Wireless Measurement System Data Sheet: MICA_data_sheet.pdf

[16] MIB520- USB Gateway Data Sheet: URL: www.dinesgroup.org/projects/images/pdf_files/mib520_datasheet.pdf

[17] MoteWorks™ Software Platform: URL: www.willow.co.uk/MoteWorks_OEM_Edition.pdf

[18] Wireless Center of Excellence (FIT) URL: http://research.fit.edu/wice/

[19] IEEE 802.15.4 OPNET Simulation Model, http://www.open-zb.net/

[20] Allen, Arnold. Probability, Statistics, and Queueing Theory with Computer Science Applications. 2nd ed. Academic Press Inc., 1990

[21] G. E. Perez, W.A. Windham, "Automating Modeling & Simulation Pre/Post Processing," in Proceedings of OPNETWORK, 2011

[22] MATLAB and Statistics Toolbox Release 2012b, The MathWorks, Inc., Natick, Massachusetts, United States.

[23] B. Genge, C. Siaterlis, I. Nai Fovino, M. Masera: A Cyber-Physical Experimentation Environment for the Security Analysis of Networked Industrial Control Systems. Computers and Electrical Engineering, Elsevier, Volume 38, Issue 5, pp. 1146-1161, 2012

[24] B. Genge, C. Siaterlis: Analysis of the Effects of Distributed Denial-of-Service Attacks on MPLS Networks. International Journal of Critical Infrastructure Protection, Elsevier, Volume 6, Issue 2, pp. 87-95, 2013

[25] G. E. Perez, I. Kostanic, "OPNET Modeler model and Real-Life WSN Platform comparison: Validating the network model using Hypothesis Testing," in Proceedings of OPNETWORK, 2013

Mobile Network Design Aspects

Rodney Rambally, Yufei Wu
Center for Information and Communication Technology
University of Trinidad and Tobago
Port of Spain, Trinidad and Tobago

ABSTRACT

This paper analyzes planning aspects of WCDMA mobile radio network deployment and proposes optimization models which explicitly take into account some important factors such as QoS and power control. It also proposes a tabu search algorithm to solve the overall planning problem considered as NP-hard. Computational experiments with realistic problem sizes are conducted to describe some important aspects of efficient WCDMA deployment, and show both the efficiency and the practicality of the tabu search algorithm.

Keywords: Mobile network planning and optimization, NP-hard, Tabu Search, WCDMA

1. INTRODUCTION

A good planning and optimization objective is extremely important in selecting an effective deployment scenario. In [2][3][4], the models proposed are for both microcells and picocells in coverage limited environments. In [5], authors propose a model which considers interference limited environments and use an objective function which directly related to QoS. In [6], the goal of mobile network planning and optimization is to cover the maximum number ofsubscribers in an effective manner. In [7] a profit maximization model is presented. In [8] a cost minimizing planning and optimization model is developed. Planning 3G mobile networks, such as UMTS, is even more sensitive to the planning objective due to the inherent CDMA features [9].

This paper analyzes planning aspects of 3G WCDMA mobile radio network deployment, and provides some insights into efficient network planning and optimization and choosing a good planning objective by taking into account operators' business demands.

2. SYSTEM MODEL

In this section, we present the system model for the third generation mobile hierarchical cell planning and optimization problem. We also define the decision variables, design constraints and objective functions.

Working Area and Traffic
A set of sites are candidates for the positioning base stations, denoted by $S = \{1,\ldots,m\}$, where a base station (BS) can be installed and that an installation and maintenance cost C_j is associated with each candidate site j, $j \in S$. Each site is defined by its coordinates (x, y), and eventually by z (height above sea level).A set of traffic test points (TPs) are denoted as$I = \{1,\ldots,n\}$. Each TP $i \in I$ can be considered as a centroid where a given amount of traffic d_i is requested and where a certain level of service (measured in terms of SIR) must be guaranteed. The required number of simultaneously active connections for TP i, denoted by u_i, turns out to be a function of the traffic, i.e., $u_i = \phi(d_i)$.

Decision Variables
In general, a BS antenna can be in one out of q different configurations, denoted by set $L = \{1,\ldots,q\}$. A configurationrepresents a sextuplet BS = (location, type, height, tilt, azimuth, power). This accounts, for instance, for a variable tilt selected out of a set of possible angles with respect to the vertical axis, and for a variable height selected from a finite set of values with respect to the ground level. Since propagation gains depend on the BS antenna configuration, we denote by g_{ij}^{w} the propagation gain from TP i to potential site j if the BS antenna is in configuration w. The decision variables are needed for each configuration:

$$x_{ijw} = \begin{cases} 1 & \text{if TP } i \text{ assigned to BS } j \\ & \text{with configuration } w \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

$$y_{jw} = \begin{cases} 1 & \text{if BS } j \text{ with configuration } w \\ 0 & \text{otherwise} \end{cases} \quad (2)$$

for$i \in I$, $j \in S$ and $w \in L$.
.
Decision Constraints
Constraints (3) make sure that each TP i is assigned to at most one BS. Note that by restricting the assignment variables x_{ijw} to take binary values, it is required that in every feasible solution all active connections must be assigned to a single BS.

$$\sum_{j \in S} \sum_{w \in L} x_{ijw} \leq 1 \quad (3)$$

Constraints (3) are relaxed and intentionally allow some TPs not to be assigned.Constraints (4) are called minimum service requirements, which ensure that service is available in the working area that have at least a proportion β of all traffic demand nodes

$$\sum_{j \in S} \sum_{w \in L} \sum_{i \in I} \mu_i x_{ijw} \geq \beta . \sum_{i \in I} \mu_i \quad (4)$$

In our model, the cost of a BS involves the cost of site

installation and cost of the configuration:

$$C_j(y_{jw}) = C_j^S + C_j^L \quad (5)$$

The overall cost of a radio access network in the predefined working area, C(***y***), is the sum of the non-configuration cost of each BS antenna C_j^S , and its associated configuration cost , i.e., C(***y***) = $\sum_{w \in L} \sum_{j \in S} y_{jw}.C_j(y_{jw})$. Cost is an extremely important factor for choosing an adequate network configuration. Denote C_{max}an externally given ceiling cost, or a budgetary limit in total monetary investment. In most cases, it is practical to consider the budget constraints (6).

$$\sum_{w \in L} \sum_{j \in S} y_{jw}.C_j(y_{jw}) \le C_{max} \quad (6)$$

$$x_{ijw} \le \min\left\{1, \frac{g_{ij}^w P_{\max}}{P_{tar}}\right\} y_{jw} \quad (7)$$

Constraints (7) correspond to the most stringent constraints among the coherence constraint $x_{ijw} \le y_{jw}$, which ensures that TP *i* is only assigned to site *j* if a BS with configuration *w* is installed in j, and the power limit on a single connection from BS *j* to TP *i*:

$$\frac{P_{tar}}{g_{ij}^w} x_{ijw} \le P_{\max} y_{jw} \quad (8)$$

whereP_{max} is the maximum emission power for the connection from site *j* to TP *i* and P_{tar} / g_{ij}^w corresponds to the emission power required by BS *j* to guarantee the target received power Ptar at TP *i*. For each pair of site $j \in S$ and TP $i \in I$, constraints (8), which are active only if TP *i* is assigned to BS *j* (i.e., x_{ijw} = 1), correspond to the signal quality requirement. Finally, constraints (9) impose an upper limit P_{tot} on the total emission power of every BS.

$$\sum_{i \in I} \frac{P_{tar}}{g_{ij}^w} x_{ijw} \le P_{tot} y_{jw} \quad (9)$$

In addition to the constraints (8) and (9), the quality of service constraints should be emphasized. Since in a power-based power control mechanism P_{tar} / g_{ij}^w is the power that needs to be emitted from a BS with configuration *w* in site *j* to guarantee a received power of P_{tar} at TP *i*. For each connection between a BS installed in j and a TP *i* falling in a sector of this BS, the *SIR* constraints can be expressed as follows:

$$\frac{P_{tar} x_{ijw}}{I_{\text{int}er} + I_{\text{int}ra}} \ge SIR_{\min} x_{ijw} \quad (10)$$

Equation (11) represents the total interference incurred in the same cell, whereas Equation (12) describes the interference from all the other BSs, measured at mobile unit i in the service area.

$$I_{intra} = \alpha \left(\sum_{\substack{k \in I_j^{\sigma_{ijw}} \\ x_{kjw}=1}} u_k \frac{g_{ij}^w P_{tar}}{g_{kj}^w} x_{kjw} - P_{tar} \right) \quad (11)$$

$$I_{inter} = \sum_{v \in L} \sum_{\substack{l \in S \\ l \ne j}} \sum_{\substack{k \in I_l^{\sigma_{ilv}} \\ x_{kl}=1}} u_k \frac{g_{il}^v P_{tar}}{g_{kl}^v} x_{klv} \quad (12)$$

where for any site $l \in S$, $w \in L$, the index set $I_l^{\sigma_{ilw}}$ denotes the set of all TPs in *I* that fall within the sector σ_{ilw} of the BS with configuration *w* and location *l*, which contains TP *i*.

Problem Formulation

We will introduce three formulations of the cell planning problem. In all cases, the following variables are the basic decision variables. Based on these basic decision variables, most of radio access network parameters can be derived from.

1) The number of selected base stations and their configuration, denoted by multi-dimensional vector ***y***
2) The capacity assignment matrix, ***x***
3) The power assignment vector (mobile transmitter participation), ***p***

Minimal Cost Planning: A practical objective deals with the price of the solution in terms of installation and provision costs. In this formulation, the goal of the planning is to achieve as low cost as possible.

Minimize $$\sum_{w \in L} \sum_{j \in S} y_{jw}.C_j(y_{jw}) \quad (13)$$

Instead of optimizing the technical performance, such as coverage outage, which would potentially lead to a network with unnecessary high resource usage, we choose the objective for minimizing the network cost. The planning objective is defined as follows:

Maximum Capacity Planning: A more real-life formulation of the cell planning problem is to aim for maximizing the satisfied capacity demands. The optimization problem can be written as:

Maximize $$\sum_{w \in L} \sum_{j \in S} \sum_{i \in I} \mu_i x_{ijw} \quad (14)$$

The objective function is the sum of the served capacity demands. The constraints for this optimization scenario are the same as in the previous formulation.The model is to maximize the total annual profit generated by the cellular network operator, which is equal to the total annual revenue minus the annual costs. Mathematically we have:

$$\text{Maximize} \quad [\theta \sum_{w \in L} \sum_{j \in S} \sum_{i \in I} \varepsilon \mu_i x_{ijw} - \sum_{w \in L} \sum_{j \in S} y_{jw} . C_j(y_{jw})] \qquad (15)$$

εdenotes the annual revenue ($) generated by each channel utilized in the working area. $\theta$is a weighting factor. Relation (15) represents the maximum profit optimization when θ = 1.All three formulations (13), (14) and (15) are subject to constraints (3) – (12).

3. SOLUTION PROCEDURE

In order to apply tabu search to solve the planning problem, we need to define:

1) An initial feasible solution
2) Representations for feasible solutions
3) Neighborhoods for feasible solutions
4) Search techniques for neighborhoods, and
5) Evaluation methods for gains in objective values

Solution Structure and Neighborhood
Decision variables are the BS locations, their powers, their antenna heights, etc. Given these decision variables, a radio access network configuration can be defined as a set of vectors [(p_1, h_1, …), …, (p_m, h_m, …)], which can be represented abstractly by the network configuration vector ***y***. In practice, configuration parameters can take values from a certain range.After y is decided, every traffic demand node TP $i \in I$is assigned to a serving BS using a capacity assignment algorithm, described later in this section, that is, to determine the capacity assignment pattern, denoted by vector ***x***.

Each feasible search space point, denoted by ***J***(*x*, *y*), is a particular set of locations, powers, heights, and other configurations for each BS, and a particular assignment pattern of traffic demand nodes to each selected BS satisfying the various constraints. To generate a new neighbor, two sets of neighborhood generating operators are required, one that moves the locations and configurations of BSs and another that changes the capacity assignment pattern for each BS. The first set of operators is defined as follows:

1) *On-Off:* a BS site is chosen randomly. If there is a BS at the site, it is removed. If there is no BS at the site yet, a new BS is placed at the site.
2) *Local Move:* one of the decision variables (power, height, or other configuration parameters) of a randomly chosen BS is appointed randomly, and the new neighbor is generated by taking its value one size above or one size below its current value.

Capacity Assignment Problem
The second set of operators is the capacity assignment algorithm. Given the locations of BSs, their powers, heights and other configurations, demand nodes I should be assigned first to the available BS that has the largest signal attenuation factor before establishing connections to other BSs [11]. The algorithm works like this:

1)*Step 0:* Start with a given access network configuration ***y***.
2) *Step 1:* For each $i \in I$, calculate minimum power P_{tar} / g_{ij}^{w} according to propagation matrix $G = [g_{ij}^{w}]$; assign demand node *i* to its closest BS j, requiring the minimal transmit power; calculate ***x***. In this step, constraints (7) are automatically satisfied.
3) *Step 2:* If ***x*** from Step 1 and ***y*** satisfy constraints (9), go to Step 3; otherwise repeat the process: randomly select and disconnect a demand node *i* belonging to the overcrowded BS j, which will reduce its transmit power accordingly, until constraints (9) are satisfied.
4) *Step 3:* If ***x*** from Step 2 and y satisfy constraints (10), go to Step 4; randomly select and disconnect a demand node i belonging to the overcrowded BS j, which will reduce its transmit power accordingly, until constraints (10) are satisfied.
5) *Step 4:* Output final capacity assignment vector ***x***.

Initial Solution Generation
An initial network configuration is generated by intuitively (randomly) placing BSs at potential locations with a uniform distribution, in such a way that the number of initial locations is approximately half the total number of possible locations in our implementation, and assigning their powers, antenna heights, and other configuration parameters within the respective feasible ranges. Then every traffic demand node TP *i* is assigned to a closest serving BS using the demand assignment algorithm, described earlier in this section.The next step is the optimization process.

Tabu Search
The tabu search implementation for the cell planning and optimization problem may be described as follows:

1)*Step 0:* $l \leftarrow 0$. The counter of the algorithm iterations, *l*, is initialized. An initial solution $\boldsymbol{J}^o(\boldsymbol{x}, \boldsymbol{y})$ is chosen randomly in such a way that the number of BSs is equal to half the total potential locations, and that the power, the height and other configuration parameters of a selected BS are chosen randomly from an element of the corresponding feasible set. Then, the capacity assignment algorithm is applied to generate the capacity assignment pattern. Calculate the objective function, $f(\boldsymbol{J}^o)$ from relation (13), (14) or (15). The set of taboo and aspirant moves is initialized, i.e., $T(l) = \varnothing$, and $A(l) = \varnothing$. A candidate list $M(l)$ is initialized.
2)*Step 1:* If the stop criterion is satisfied, the procedure ends and a transition to Step 9 is performed.
3)*Step 2:* The set of move operators *M* is applied to solution J^l, and hence, a new set of candidate solution list $M(l)$ is produced. Each move produces a new neighbor of the search space point.
4)*Step 3:* The $M(l)$ set is examined to satisfy the constraints (8), (9), and (10) forms the new set of solutions $N(l)$ that are neighbouring to solution J^l.

5) *Step 4:* The set of solution, $C(l)$, that are candidate for obtaining the best solution status, and therefore, for replacing solution J^l in the next algorithm iteration, is formed through the relation $C(l) = N(l) – T(l)$. Moreover, solution J^l is appended in the $C(l)$ set.
6) *Step 5:* The $A(l)$ set is formed. More specifically, the objective function value that is scored by the solutions in the $T(l)$ set is computed. Those solutions that improve the objective function by more than a given level are removed from the $T(l)$ set and placed in the $A(l)$ set.
7) *Step 6:* The set of solutions $C(l)$ is enhanced through the relation $C(l) = C(l) \cup A(l)$.
8) *Step 7:* The solution of the $C(l)$ set that is the best in improving the objective function becomes the best solution that will be used in the next algorithm iteration.
9) *Step 8:* $l \leftarrow l + 1$. The next algorithm iteration is prepared. Therefore, the set of tabu moves that will be used in the next algorithm iteration is updated through the relation $T(l + 1) = T(l) \cup M(l)$. Moreover, solutions that have stayed in the taboo set for more than a given number of algorithm iterations are removed form the $T(l + 1)$ set. Finally, $A(l + 1) = \varnothing$ and $C(l) = \varnothing$. A transition to Step 1 is performed.
10)*Step 9:* End.

4. SIMULATION RESULTS

Our purpose with the following quantitative examples is to illustrate the tradeoff between capacity and cost. Table 1 contains important planning input data.

TABLE I
3G CELL PLANNING DATA

Parameters	Values
Mobile antenna height	1.8 m
Frequency	2 GHz
Mobile antenna gain	0 db
BS antenna gain	14 db
SIR_{min}	0.009789
E_b/I_o	7 db
Processing gain	512
Mobile receiver sensitivity	-110 dBm
WCDMA orthogonality	0.7
Thermal noise density	-130 dBm/Hz
Annual revenue per channel	$10,000

Let us assume that the task is to design 3G downlink radio access network to provide conversational service over a predefined urban working area 1.5 km x 1.5 km. There are 500 demand nodes (n) uniformly distributed, and for the sake of simplicity, each demand node channel requirement $\mu_i$takes one value from the set {1, 2, 3} for each $i \in I$. There are 100 potential candidate BS locations (m) which are randomly generated with an uniformly distribution.

Assume that annual site non-configuration cost is $100K for each potential site. BS antennas are assumed to be omnidirectional at every site. COST 231 Hata urban propagation model is used to generate configuration gain matrix $G = [g_{ij}^{w}]$.From Table 2, intuitively, BS antenna height configuration costs are not significant when compared to other cost components. We apply tabu search to solve the above planning problem, but using alternative objective functions, according to the following three scenarios:

TABLE II
FEASIBLE VALUES FOR ANTENNA POWER, HEIGHT AND COSTS

Max transmit power		BS antenna height	
Permitted values (watts)	Cost (unit $K)	Permitted values (m)	Cost (unit $K)
20	100	10	10
40	150	20	20
80	200	30	30

Capacity Optimization (CO): Cost is completely disregarded during the optimization, the objective function is formulated in relation (14) to maximize the served traffic in the working area (or minimize the number of unserved traffic points where some constraints are not satisfied (outage). For simplicity, we call this scenario pure capacity optimization.

Cost Optimization (COST): Capacity factor is completely ignored during the optimization, the objective function is formulated in relation (13) to minimize the total cost and hopefully find the cheapest feasible network configuration during the optimization process.

Combined Cost and Capacity Optimization (COM): Fig. 1 summaries the results of four representative values, $\theta = 0.1$, 1.0 and 10.As it is exemplified by the $\theta = 0.1$ case in Fig. 1. The $\theta = 1$ case already represents a situation where network configurations have on average a higher capacity and cost than feasible configurations with low network cost. The $\theta = 10$ case makes solutions cluster than $\theta = 1$. Increasing θ further does not lead to additional capacity improvement (not shown here).

Fig. 2 summaries the results of the three optimization cases *CO*, *COST*, *COM* in terms of the total cost of the obtained network configurations. The histograms are generated from the results of 100 independent tabu search runs for each of the three cases. We use the same parameters and test cases as above for *CO*, *COST*, and *COM*, and apply $\theta = 1$ for *COM*. It can be seen that pure cost optimization case yields considerable cost reduction when at least 40% traffic demand must be satisfied.

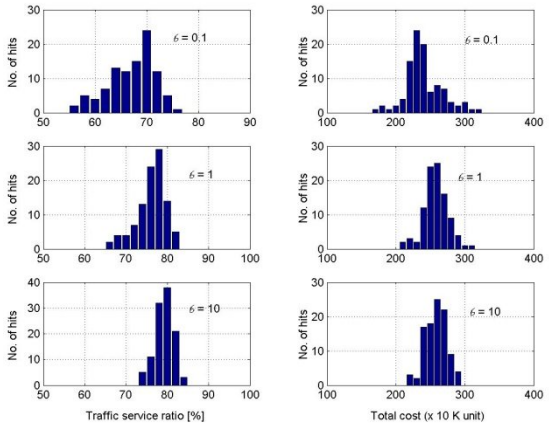


Fig. 1. Overall traffic coverage ratios and total cost histograms for three different capacity weighting factors, $\theta = 0.1$, 1 and 10.

Likewise, pure capacity optimization yields considerable cost increase. Here we assume that the budgetary constraint allows

no more than 20 BS sites installed. The combined cost and capacity optimization case lies somewhere between two extreme cases, striking a meaningful tradeoff. For explanation we can look at Table 3, which contains that statistical results of 100 resulted network configurations found by tabu search for each objective (*CO*, *COST*, *COM*).

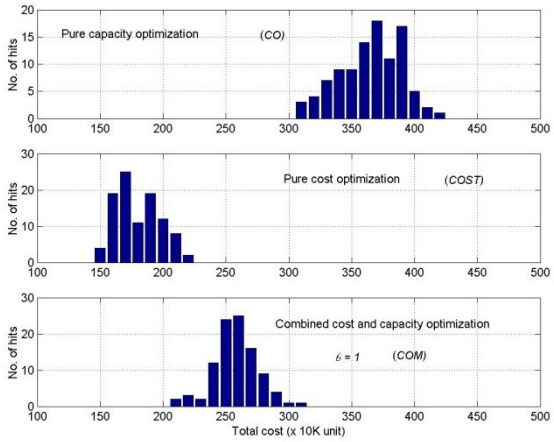


Fig. 2. Resulting total cost values for pure capacity optimization, pure cost optimization, combined cost and capacity optimization ($\theta = 1$).

TABLE III
ALLOCATED RESOURCES FOR SCENARIOS *CO*, *COST*, *COM*[a]

Optimization case	*CO*		*COST*		*COM* ($\theta = 1$)	
	best	mean	best	mean	best	mean
No. of BS	12	14.78	5	6.60	8	10.71
Total power	56.81	57.29	53.98	55.46	55.05	56.17
Average power	46.02	45.59	46.99	47.27	46.23	45.87
Average height	17.05	16.08	22.00	22.12	17.50	17.48
Total cost	3060	3745	1410	1866	2040	2727

[a]Measurement Unit: power [dBm], height [m] and cost[$K]

Comparing the best achievable results of *CO* and *COM*, the total power usage (i.e., *CO*, 56.81 dBm and *COM*, 55.05 dBm) and the average antenna height (*CO*, 17.05 m and *COM*, 17.50 m) are approximately the same for both objectives, but the number of BSs is decreased from 12 (*CO*) to 8 (*COM*). This result indicates that the network remains "over-provisioned" under *CO*, that is, the optimization does not attempt to remove unnecessary BSs, neither to cut back.

5. CONCLUSION

This paper analyzes planning aspects of WCDMA mobile radio network deployment and proposes optimization models which explicitly take into account some important factors such as QoS and power control. It also proposes a tabu search algorithm to solve the overall planning problem considered as NP-hard.

6. REFERENCES

[1] M. R. Garey and D. S. Johnson. **Computers and Intractability: a guide to the theory of NP-completeness**, W. H. Freeman and Company, 1979.

[2] H. R. Anderson and J. P. McGeehan, "Optimizing microcell base station locations using simulated annealing techniques," **Proceedings of IEEE Vehi. Tech. Conf**., vol. 2, June 1994, pp. 858-862.

[3] H. D. Sherali, C. M. Pendyala, "Optimal location of transmitters for microcellular radio communication system design," **IEEE J. Selected Areas in Communications,** vol. 14, No. 4, May 1996, pp. 662-673.

[4] D. Stamatelos and A. Ephremides, "Spectral efficiency and optimal base station placement for indoor wireless networks," **IEEE J. Selected Areas in Communications,** vol. 14, No. 4, May 1996, pp. 651-661.

[5] K. W. Cheung, and R. D. Murch, "Optimising indoor base station locations in coverage and interference limited indoor environments," **Proceedings of IEE Communications,** Dec. 1998, pp. 445-450.

[6] R. K. Rawnsley, and S. Hurley, "Towards automatic cell planning," **Proceedings of the 11th IEEE International Symposium on Personal, Indoor, and Mobile Radio Communications,** Sept. 2000, pp. 1583-1588.

[7] J. Kalvenes, J. Kennington, and E. Olinick, "Hierarchical cellular network design with channel allocation," **Technical Report 01-EMIS-08**, Southern Methodist University, 2001.

[8] A. Dutta and V. Hsu, "Cellular network design site selection and frequency planning," **Annals of Operations Research**, vol. 106, 2001, pp. 287–306.

[9] C. Y. Samuel, **CDMA RF System Engineering**, Artech House, 1998.

[10] E. Amaldi, A. Capone, and F. Malucelli, "Discrete models and algorithms for the capacitated location problem arising in UMTS network planning," **Proceedings of ACM Dial-M**, 2001, pp. 1-8.

Computer System of Modeling and Control Population Dynamics with Continuous Age

Dr. Youry Zagorodnii
Complex Modelling Systems
Taras Shevchenko National University,
64 Volodymyrska Str. Kyiv, Ukraine, 01030
+ 38 (044)-259-05-34
satr@unicyb.kiev.ua, yuzagor@ukr.net

and

Dr. Volodymyr Voytenko
Applied Science and Technology
Sheridan College Institute of Technology and Advanced Learning,
1430 Trafalgar Rd., Oakville, Ontario, Canada, L6H 2L1
+1 (905) 845-9430 Ext. 2242
volodymyr.voytenko@sheridanc.on.ca

Different population models are used in interdisciplinary areas to model the dynamics of wildlife or human populations. Normally, population dynamics depends on birth and death rate, immigration and emigration, ageing populations or population decline.

In this research we present a system of modeling and control population dynamics with continuous age. Let a population dynamics is described by the function $w(\tau,t)$ as the density of the members' distribution by the biological age $\tau \in [0, \tau_m]$ in time $t \in [0, T]$, with the field of definition $Q_T = \{(\tau, t): 0 \le \tau \le \tau_m, 0 \le t \le T\}$ [1].

This function could be defined by the equation below:

$$w(\tau,t) = c_1 + c_2 e^{\alpha_1 t + \beta_1 \tau} + \left(c_3 + c_4 e^{\alpha_2 t}\right) * \sin\left(c_5 + c_6 t + c_9 t^2\right)\sin\left(c_7 + c_8 \tau\right), \quad (1)$$

$(\tau,t) \in Q_T$,

where $c_1, c_2, c_3, c_4, c_5, c_6, c_7, c_8, c_9, \alpha_1, \alpha_2 \in R$ are the real parameters, which can be determined using statistical data and may be used for the population dynamics control problem. The function $0 \le \varphi(\tau) \le \varphi_0$ is an initial distribution of the density, if $w(\tau,0) = \varphi(\tau)$.

A method of the parameters identification for the function (1) was found. It was entered the next criteria of the favorable development for the population dynamics control problem:

$$M(\tau,t_1,t_2) = \frac{1}{t_2 - t_1}\int_{t_1}^{t_2}\left(\ln\frac{w(\tau,t)}{\varphi_s(\tau)}\right)^2 d\tau, \quad (2)$$

$$J = \frac{1}{\tau_m}\int_0^{\tau_m} M(\tau,t_1,t_2)d\tau \to \min,$$

where $\varphi_s(\tau)$ - the function of the population age-distribution during the period $t \in [t_1, t_2]$, $t_1, t_2 \in [0, T]$, $t_1 < t_2$ in the case of the best conditions. Now, let's define the function of the population general numeric property as:

$$G(t) = \int_0^{\tau_m} g(\tau) w(\tau,t) d\tau, \quad (3)$$

where $g(\tau)$ is a function of the property of the population's member at the age $\tau \in [0, \tau_m]$. The function of the population number $N(t)$ may be considered as the function $G(t)$, where $g(\tau) \equiv 1$.

Then,

$$N(t)=\int_0^{\tau_m} w(\tau,t)d\tau = a_1 + a_2 e^{-\alpha_1 t} + \\ + a_3\left(c_3 + c_4 e^{\alpha_2 t}\right)\sin\left(c_5 + c_6 t + c_9 t^2\right),$$

where $a_1 = c_1\tau_m$,

$$a_2 = \frac{c_2}{\beta_1}\left(e^{-\beta_1\tau_m} - 1\right),$$

$$a_3 = \frac{\cos(c_7) - \cos(c_7 + c_8\tau_m)}{c_8}$$

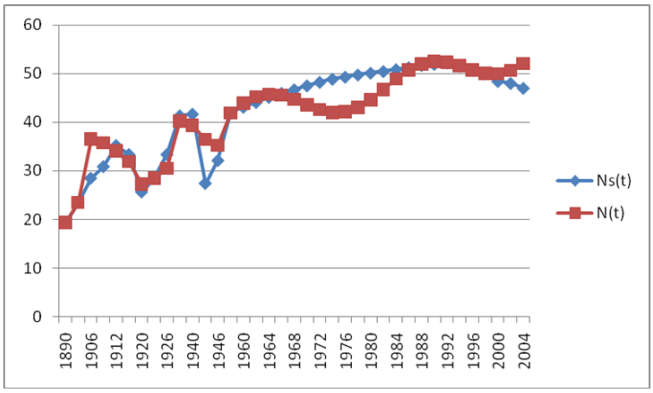
We designed and developed computer system modeling which helps us to use the model described above (1)-(3) for population dynamics analysis. This system includes the following parts:

- subsystem of simulation population growth for different functions of birth density, rate of the dearth and initial distribution;

- subsystem of the model parameters identification;

- subsystem of solving the problem of controlling the population growth during the specific time period.

As practical implementation, the system above was used for simulation of the Ukrainian and Canadian population dynamics during selected time period of 1890-2004 years [2, 3], where statistics data was available. We used this system for solving problem of parameter identification and simulation of the population growth based on experimental data for the time period. Results of the function of the population number $N(t)$ were compared with statistical data $N_s(t)$. It has the following parameters: a_1=6.03, a_2=21.3, a_3=1, c_3=23.5, c_4=6.1, c_5=−1.87, c_6=0.198, α_1=0.007, α_2=−0.021, c_9=0.000272, τ_m=100. This data are represented in the picture 1.



Picture 1. Numeric graph of the population dynamics $N(t)$.

As result, a relative error of the model will be calculated as follow:

$$\delta = \frac{1}{k}\sum_k \frac{|N_s(t_k) - N(t_k)|}{N_s(t_k)} \cdot 100\% = 6{,}38\%.$$

In this paper, we presented the experience with computer system of modeling and control population dynamics with continuous age. Obtained model solutions from the system allow us to find out and analyze basic lows of the population behavior and solve some problems of the parameters identification.

References

[1] Akimenko V.V., Zagorodnii Yu.V. Modeling of dynamics of monocycle cells aggregation, Cybernetics and systems analysis, Ukraine, 47 (1), 2011, p. 29-43.

[2] Zagorodnii Yu., Voytenko, V. Calculations of functions for a monocyclic population dynamics model with continuous time age. The 20th Proceedings of the IASTED Conference on Modeling and Simulation, Banff, Canada, 2009. - p. 112 – 115

[3] Zagordonii Yu. , Korobko T. About one developing model of social and biological systems, Ecology and human safety. Ukraine, 2005.№2, p.71-77

CONCEPT MAPPING FOR THE EFFICIENT GENERATION AND COMMUNICATION OF SECURITY ASSURANCE CASES

John W. Coffey, Dallas Snider, Thomas Reichherzer, Norman Wilde
Department of Computer Science
The University of West Florida
Pensacola, FL 32514, USA

ABSTRACT

The development of security assurance cases has been touted as one way to improve the security of mission-critical software. However, security assurance cases are not easy to write, communicate, or introduce into the software development process. We describe a two-phase approach to the development of security assurance cases: a first phase in which critical vulnerabilities are identified, and a second phase in which documentation is produced demonstrating that these vulnerabilities have been addressed. Concept maps, an easily understood graphical representation of conceptual knowledge are used to construct the security assurance case. The current work contains a description of a pilot study in the use of this approach.

1. INTRODUCTION

Today's utterly pervasive reliance on information technology, coupled with the relentless onslaught of malicious attacks on information systems, combine to create an overriding concern for the development of secure software. The creation of security assurance cases has been proposed as a way to establish security properties of software [1]. While holding promise to improve software security, security assurance cases are not easy to write, communicate, or introduce into time-constrained software development processes. Clearly, finding efficiencies in the process of addressing security issues in software development is an important contemporary concern.

Implementing the security assurance case concept is made difficult by the large number and diverse nature of security requirements enumerated in large, complex checklists and standards such as the U.S. Department of Defense's *Application Security and Development Checklist* [2]. The sheer number of issues in such checklists and the complexity of making the case that they have been addressed, make utilization of such checklists generally unfeasible for all but the most highly security-critical systems.

In this paper we propose a principled (versus ad-hoc) approach to the development of more human-scale security assurance cases by leveraging expert knowledge of attack profiles. We propose a team-based, knowledge engineering approach that constructs assurance cases in the form of concept maps [3]. A concept map provides a simple visual representation for the capture and communication of knowledge such as security concerns in software. The approach proposed here holds promise to provide two efficiencies in the process of developing security assurance cases: concept maps are easy to elicit and build, and eliciting expert knowledge regarding the most pressing security concerns creates focus for the security assessment.

In this article, we provide a discussion of literature pertaining to security assurance cases and concept mapping. We present a two-part approach to the conceptualization and development of a security assurance case and then discuss a pilot study that we conducted to gain understanding and feedback on the practicality of the approach we propose. We describe the methods employed and we summarize results of the study including some measures of the time involved to build a security assurance case. We conclude with a discussion of benefits of the approach and lessons learned.

2. SOFTWARE SECURITY ASSURANCE

Assessing software security requires evaluating targets (systems that may be attacked), processes (used to develop the targets), and remediation (corrective action to mitigate vulnerabilities) [4]. Security assurance cases fall at the intersection of these three concerns; they are developed for a specific target as part of a Software Engineering process, and they may identify vulnerabilities for remediation. Security assurance cases provide evidence that specific security concerns have been addressed. Security assurance cases must be developed and reviewed at various times (called *touch points*) in the software development lifecycle. For example, it is better to address security concerns during the design of the software than to attempt to retrofit security features during implementation.
Additionally, the software implementation must be assessed to ensure that security features in the design

have been properly incorporated. As such, a security assurance case evolves during the development process. Software security assurance cases are prepared at these pre-defined security touch points during the software development lifecycle. Throughout the lifecycle, the security assurance case evolves as it is reviewed by stakeholders with varying areas of expertise. Stakeholders include software developers, testers, installers, system administrators and customers [5]. Since people with so many different backgrounds are involved, an easily understood, easily maintained representation for an assurance case is important.

The software security assurance case also creates a structure for the analysis of changes to a system in order to ensure that the changes do not have adverse effects on security. A software security assurance case will continue to evolve through new versions of an existing system and the security framework of the case may be adaptable for a new system. A properly created assurance case will take into consideration the personnel, processes and technology involved in the development and delivery of software. Arguments based on personnel quality might be based on an employee's training and experience in software security. Process arguments could be based on established testing procedures, bug tracking, code management and release schedules. Technology arguments are made in terms of properties of hardware, operating systems and integrated development environments [6].

Several standards for software security assurance have been developed including the aforementioned U.S. Department of Defense's *Application Security and Development Checklist* [2], *8500.2 Information Assurance Implementation* [7] and the U.S. Department of Commerce's *SP800-53 Recommended Security Controls for Federal Information Systems and Organizations* [8]. It might be argued that these documents create as many problems as they solve. Adequately addressing all the issues they raise is difficult and expensive. Some issues are contradictory or at least, subject to interpretation [9]. The difficulty of implementing security assurance cases based upon such extensive standards provides impetus for the approach we describe next.

3. CREATING SECURITY ASSURANCE CASES WITH CONCEPT MAPS

Concept maps provide a simple visual representation of the concepts and the relationships between them in a domain of knowledge. Concept mapping has been used extensively to capture domain knowledge for purposes of knowledge preservation, knowledge generation, communication, and management [10]. Concept maps are well established in a wide variety of domains and experience levels and they are excellent for the communication of structured knowledge [11].

For security assurance cases, there are typically two distinct areas of knowledge that must be brought to bear: expertise about security vulnerabilities and expertise about the specific software system for which a security assurance case is being developed. It is a relatively simple matter to elicit and capture such knowledge in concept maps. Initially, expert knowledge of the threat environment in which the system is to be deployed might be elicited in order to identify the issues the software must address. Although potentially iterative, this activity, a collaborative effort between a security expert and a knowledge engineer, initially takes place in the earliest phases of software development. Later, as the software is developed, security assessments involving the security expert, a knowledge engineer and the software developer take place at designated security touch points. Accordingly, our concept map-based approach involves two-phases:

Phase 1: The security expert and the knowledge engineer collaborate to lay out the major areas of concern regarding security threats to the system. The security expert should understand the range of attacks that must be addressed. Obviously, critical problems such as zero-day attacks [12] are essentially impossible to anticipate, but the ability to bring system and application-specific expertise strengthens the security focus significantly. The output of this phase is a skeleton concept map containing information on the security issues to be addressed. Such a skeleton map is presented in the next section (Figure 1) where we describe our pilot study.

Phase 2: Given the concept map of the most critical perceived threats, the security expert, knowledge engineer and software developer have interactive sessions to develop the security assurance case. These sessions occur at each touch point in the development process. The output of each iteration is archived, and serves as the input to the next round. A completed security assurance concept map is presented in the next section (Figure 2).

4. A PILOT STUDY

In this section, we describe a pilot study that was performed to assess the basic concept behind this approach to security assurance case development. The study was performed in a graduate project course for Master's students in Software Engineering at the University of West Florida. Participants in the study were mature students, with some professional experience either in programming or system administration. However, none of the students had any significant background in software security. All activities were conducted online since the students were widely distributed geographically. The main theme of the course was the development of new services or maintenance of existing services to enhance a Service Oriented Architecture (SOA) composite application. The development process included:

1. Preliminary design
2. Design Security Assurance Case (*touch point*)
3. Design Security Assurance Case Review, moderated by student Software Quality Assurance (SQA) leader
4. Implementation and Deployment
5. Deployment Security Assurance Case (*touch point*)
6. Assurance Case Review, moderated by student SQA leader

Phase 1 of the process was simulated by having the security expert select key security elements from the DoD *Application Security and Development Checklist* [2]. It was a consequence of the current work on Phase 2 tasks that the utility of knowledge elicitation from the security expert regarding the critical security concerns was identified as a useful separate step. For that reason, only a simulation of the first phase is available for the current study.

Four security concerns were selected for review: the service was not to be subject to error handling vulnerabilities, the service needed to support the creation of transaction logs for access and changes to data, the service could not contain embedded authentication data, and the service had to execute with no more privileges than necessary for proper operation. These requirements were rendered in the skeleton concept map in Figure 1. This skeleton map provided the starting point for the Phase 2 security touch point reviews.

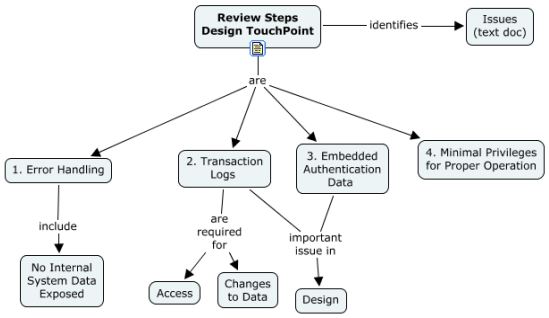


Figure 1. A skeleton concept map showing security vulnerabilities to be addressed.

In Phase 2, two knowledge engineering sessions were conducted with each of the developers. The first one was held at the Design Security Assurance Case touch point and the second at the Deployment Security Assurance Case touch point. During each of these sessions, the software developer was interviewed by the security expert and a knowledge engineer who was responsible for the capture of knowledge through the construction of the concept map. The knowledge engineer started with the skeleton concept map and added concepts and notes for follow-up items (identified deficiencies in the design). After each interview, the programmer and knowledge engineer added concepts, code samples and interface documents that would help to make the case that the code was secure. Following each round of interviews, the software developers presented their concept map assurance cases for review by their peers.

Figure 2 is a screen shot showing one of the resulting implementation security assurance cases. The original skeleton map from Figure 1 may be seen at the top of Figure 2. The remainder of the map in Figure 2 was elicited during the interview. Although somewhat difficult to read at the resolution in this work, the entire map is included to provide an indication of the size of a case that was elicited in approximately one hour. In the current example, the case makes explicit security concerns handled in IIS, in C# code, by Windows Communication Framework and .NET, etc. The small icons on some of the nodes indicate links to documents (code or design) that present evidence of where and how the security issue was addressed. More complicated cases would have involved sub-maps with more detail, linked together into a hierarchical structure.

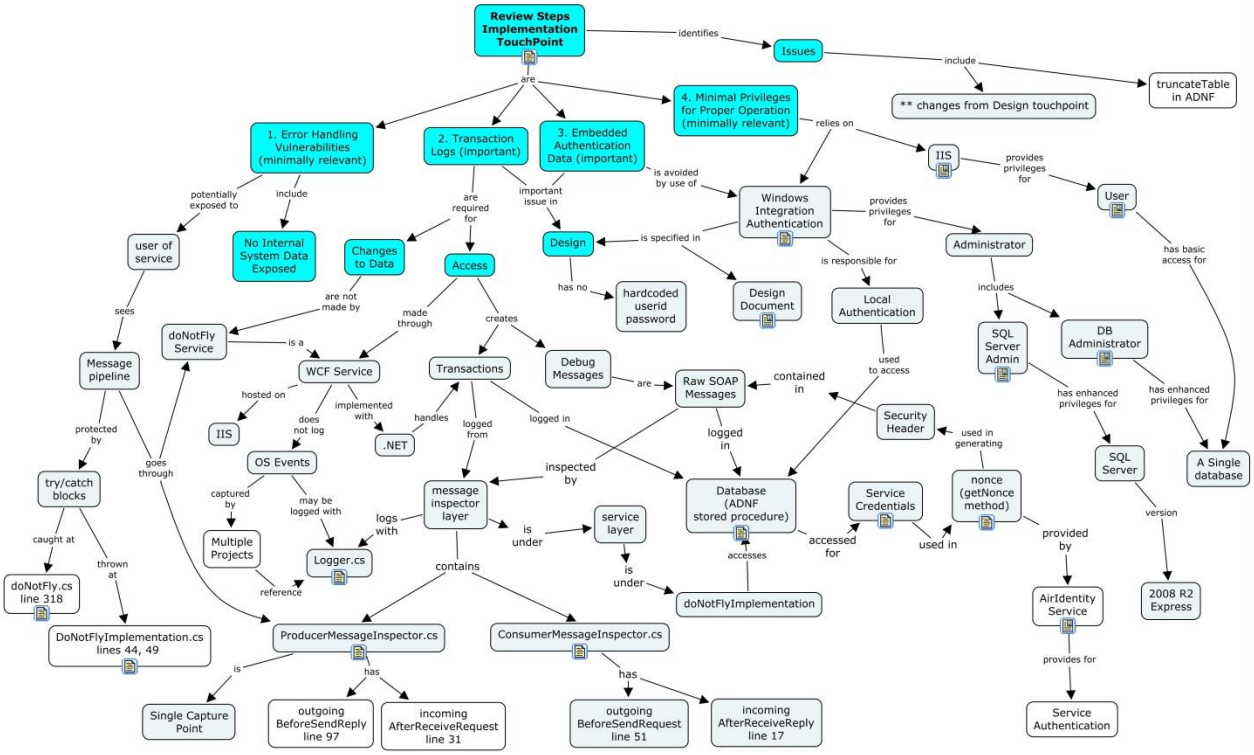


Figure 2. A Concept Map of the Implementation Security Assurance Case

5. RESULTS OF THE PILOT STUDY

Two separate teams of security experts and knowledge engineers were used in the pilot study. The knowledge engineers were the only participants who were familiar with the idea of concept mapping. Despite the fact that the security experts and software developers lacked familiarity with the process, the sessions ran very smoothly with both security experts and developers actively contributing to the refinement of the maps. A total of 8 sessions were held with four software developers, and 8 concept maps were produced – one per session. The maps created during the design touch point served as the starting point for the implementation touch point maps.

The main additional cost of employing this approach was the time of the three participants to conduct the interviews. Each interview lasted approximately an hour, or roughly 15 minutes for each security checklist item. The resulting concept maps were evaluated by participants to be a very good communication tool for reviews and other subsequent uses. The map in Figure 2 is representative of the size and complexity of the maps produced in the hour-long sessions. The knowledge represented in the concept maps provided a clear understanding of software vulnerabilities and how to design and implement a system to handle these vulnerabilities. The ease with which the participants came to understand both the process and the product suggests that stakeholders of varying backgrounds could understand and participate in a process that employs this approach.

6. CONCLUSIONS

This approach has several advantages. First, the knowledge engineering approach facilitates the introduction of assurance case touch points into the development process in a way that does not entail a burdensome increment in work load. Second, participation in the interviews can improve programmer sensitivity to potential software vulnerabilities. Furthermore, the concept map assurance cases could be linked to other documentation such as design rationale to provide a view of the software structure in which the security concerns are seamlessly integrated. Finally, the

visual nature of concept map assurance cases could facilitate communication with diverse project stakeholders.

The pilot study provided evidence that this process could help to streamline the creation of security assurance cases. Concept maps provided a good common ground to enable the security expert, knowledge engineer and the software developer to consider security requirements. Due to the ease with which the security expert and software developer became active participants in the development of the concept map-based case, it seems evident that a range of stakeholders would be able to understand the process and the resulting case. Impetus for this approach comes from a desire to find more efficient ways to construct security assurance cases. The small amount of time involved and the relative ease with which the cases were developed would suggest that this process can introduce efficiencies. It appears that the current approach can help to strike a balance between security and affordability, thus contributing to a simultaneous increase in system security and a reduction of overall program costs.

7. ACKNOWLEDGMENTS

Partial funding for this project was provided by Northrop Grumman through the Security and Software Engineering Research Center (http://www.serc.net). Support was also provided by the University of West Florida Foundation under the Nystul Eminent Scholar Endowment.

8. REFERENCES

[1] J. H. Allen, S. Barnum, R. J. Ellison, G. McGraw and N. R. Mead, Software Security Engineering: A Guide for Project Managers, Addison-Wesley, 2008.

[2] U.S. Department of Defense, Application and Security and Development Checklist, Version 3, Release 4, Jun. 2012.

[3] J. D. Novak and D. B. Gowin. Learning How to Learn. Cambridge University Press. 1984.

[4] J. Bayuk and A. Mostashari, "Measuring Systems Security," Systems Engineering, vol. 16, no. 1, pp. 1-14, 2013.

[5] J. Vivas, I. Agudo and J. Lopez, "A Methodology for Security Assurance-Driven System Development," Requirements Engineering, vol. 16, no. 1, pp. 55-73, Mar. 2010.

[6] C. B. Weinstock, H. F. Lipson and J. Goodenough, "Arguing Security - Creating Security Assurance Cases," Jul. 2013. [Online]. Available: https://buildsecurityin.us-cert.gov/articles/knowledge/assurance-cases/arguing-security---creating-security-assurance-cases. [Accessed Aug. 2013].

[7] U.S. Department of Defense, Instruction 8500.2 - Information Assurance Implementation, Feb. 2003.

[8] U.S. Department of Commerce, National Institute of Standards and Technology, NIST Special Publication 800-53, Recommended Security Controls for Federal Information Systems and Organizations, Aug. 2009.

[9] S. Pramanik, Increasing Security for Regulatory Constrained Systems, Through New Systems and Architecture Methodologies, Ph.D. Dissertation, C.S., U.C.C.S., Colorado Springs, CO, 2013.

[10] J. W. Coffey, R. R. Hoffman, & J. D. Novak. Applications of Concept Maps to Web design and Web Work. In R. W. Proctor & K.-P. L. Vu (Eds.), Handbook of Human Factors in Web Design, 2nd Edition. Mahwah, NJ: Erlbaum. pp. 211 – 230. 2010.

[11] J. W. Coffey and T. Eskridge, Case Studies of Knowledge Modeling for Knowledge Preservation and Sharing in the U.S. Nuclear Power Industry, Journal of Information and Knowledge Management, vol. 7, no. 3, pp. 173-185, 2008.

[12] FireEye Needle in a Haystack: Detecting Zero-Day Attacks. [Online]. Available: http://www.fireeye.com/blog/corporate/2013/09/needle-in-a-haystack-detecting-zero-day-attacks.html

Monitoring System for Guyed Towers

Hashem Raslan, Manar AlDaigami and Asmaa Abdulrahman
Department of Electrical and Computer Engineering,American University in Dubai
Dubai, 28282 Dubai, UAE
(hashem.raslan, manar.aldaigami, asmaa.abdulrahman)@alumni.aud.edu

Adnan El-Nasan
Department of Electrical and Computer Engineering,American University in Dubai
Dubai, 28282 Dubai, UAE
aelnasan@aud.edu

Sohaib Majzoub
King Saud University, Riyadh, KSA
smajzoub@ksu.edu.sa

ABSTRACT

Guyed towers are part of telecommunication infrastructure network. These towers, supported by cables to stabilize the tower, are placed in a wide geographical area to increase signal coverage and extend network services. Consequently, these towers are exposed to environmental and weather changes. This affects their stability and could disturb the signal transmitted or received by the tower's antenna. In some cases, a major weather storm can bring the tower down and interrupt the network services causing major losses due to network services failure and tower installation cost. Therefore, guyed towers have to be inspected and maintained regularly. This incurs extra effort, time, and maintenance cost, and it might not solve the problem. We propose a monitoring system that automates the inspection process and works as an early warning system by reporting the tower status to the central station and alerts operators before the tower or service failure. The tower status includes environmental changes, such as wind speed and temperature, and tension measurements on the cables.

Keywords: Guyed towers, strain gauges, monitoring, deflection, safety and sensory data.

I. INTRODUCTION

Guyed telecom towers are commonly used by telecom companies because of their low cost. Other types such as self-supporting and monopole towers, shown in figure 1, differ in their design, structure and cost. A self-support tower is based on the ground or on buildings. It is considered the most expensive due to its better supported structure. It offers a reliable option in serious weather conditions. Alternatively, a monopole tower consists of a single tube with one foundation. It has height limitations and uses minimal space requirement and hence is less expensive than a self-support tower.

On the other hand, guyed towers are generally guyed in three directions through tensioned cables (guyed cables) attached to the tower from one end and to the ground from the other end. The cables are responsible for the tower's stability. Guyed towers are considered the most cost effective because they provide more height at a lower material cost; however, they require a large free space [1].

II. MOTIVATION

The main challenge of using guyed towers is making sure that the aligned antenna, placed at the top of the tower, does not change its direction too much. The main causes for this change in direction could be:

- *Improper setup*: while installing the tower and tensioning the guyed cables
- *Weather conditions*: wind forces and temperature changes

Simple deflection of the tower might be safe but aggregated deflection may disrupt the communication signal causing poor user experience and consequently loss in revenue to a telecom business. On the other hand, severe deflection might cause the tower to collapse which incurs re-installation cost, and threatens safety of the surroundings (figure 2) [6].

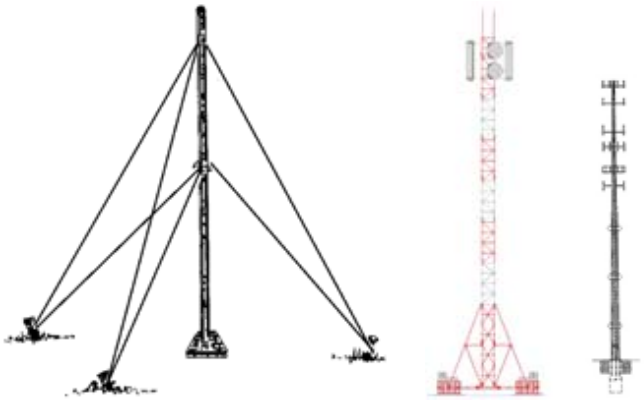


Figure 1. Telecom tower examples: (a) Guyed Towers [2] (b) Self-Support Towers [3] (c) Monopole Towers[4].

Figure 2.Examples of tower failure [5].

As a result, guyed towers require regular inspection and maintenance which is limited in remote areas, time consuming and can be expensive. It's important to know the tower condition at all times. Hence, having an automated monitoring system for telecom guyed towers could cut cost [7][8].

III. Proposed Work

We propose a system that uses a *Processing Unit* (PU) to continuously collect cable tension information and send it to a *Remote Central Monitoring Office* (RCMO). The PU monitors the tower during and after installation to acquire enough information about the tower status to report the tower's condition. The Processing Unit (figure 3) has to:

1. Acquire data about the tower from sensors.
2. Process and analyze these data.
3. Report tower's condition.

The PU will send regular updates to the RCMO about the tower's condition. Furthermore, the system should allow the engineer to check the tower's status at any time. Consequently, the communication with the PU should always be enabled and accessible at all times from the RCMO.

Figure 3. Processing Unit flow diagram.

Figure 4 shows a wide view of the system diagram. The PUs (gray boxes) are placed at different towers. A control network is used to deliver the necessary data to the RCMO.

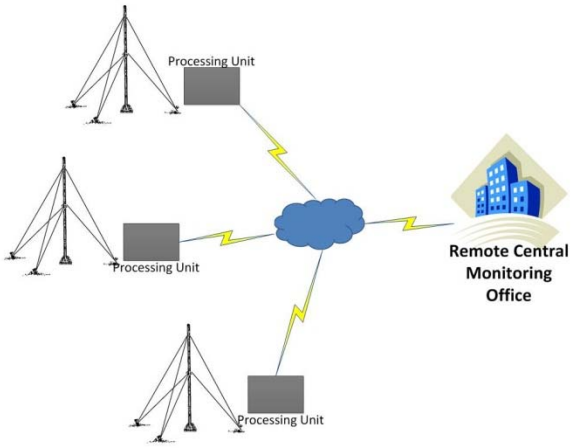


Figure 4: Main System Diagram

IV. Implementation

Knowing the strain at different parts of the tower helps understand the tower's condition. This led into the need of acquiring strain readings at a predefined set of points where the strain is maximum (*critical points*). Measuring the strain at the critical points provides the most valuable information about the tower's status and specifically its vertical alignment. Critical points on the guyed cables are selected based on the initial setup, since all cables have to be strained by a certain force to keep the tower stable. Exceeding or going below this allowable force might put the tower in a non-safe state. By measuring the strain in each cable, the exerted force on each cable can be determined. This can be processed to gain useful information about the vertical alignment of the tower's structure and consequently the alignment of the antenna at the top.

Strain Gauges

To acquire the sensory data mentioned previously, we decided to use strain gauges (a sensor that acts as a variable resistor, shown in figure 5). These sensors are usually placed on the surface of the object under strain. The gauge's resistance increase or decrease based on the force applied on the object. If the force applied is tensioning force, its resistance increases and vice-versa. Strain gages are not affected by lateral forces.

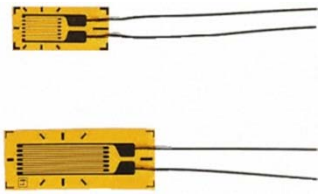


Figure 5: Strain gauge

To use the strain gauge it is initial unstrained resistance should be calculated. This can be done by measuring the resistance value for a given voltage and current values across its terminal at zero strain. Then using the following relationship, the strain can be determined as seen in Eq. (1):

Eq. (1): $$strain = (\frac{\Delta R_g}{R_g})/GF$$

where:

R_g*: initial gauge resistance.*

ΔR_g*: change in gauge resistance.*

GF: Gauge Factor (a constant number)

The main problems when using a strain gauge is the fact that its resistance changes in very small values and that they are highly affected by magnetic fields and noise sources. Therefore, they require filtering and amplifying circuitry to be able to acquire correct readings. To solve these problems we designed a filtering and amplifying circuitry that consisted of four stages: Wheatstone bridge, low pass filter, offset nulling, and differential amplifier. The Wheatstone bridge is used to create a reference voltage. The output of the Wheatstone bridge is ideally zero, but since the resistors are not of exact value the offset nulling stage was used to adjust the output of the Wheatstone bridge initially. The Temperature compensation is accomplished by using a dummy strain gauge that is not affected by any force. The output of the first stage is connected to a low pass filter to remove the undesired noise. An amplifier stage was designed to amplify the signal with a gain of 1000 V/V to be able to process the signal.

Processing Unit

The PU is the core of the system and is set near the tower. It acquires the sensory data from the tower and analyzes it into useful information that identifies the tower's condition. The processing unit consists of a microcontroller and switching circuit.

Microcontroller: We used LPC2388 controller to build our test prototype. The main task of the microcontroller is to handle the sensory data. It does that by controlling a switching circuitry which feeds analog readings from the strain gauges. The microcontroller then converts and analyzes the readings and reports the tower's condition when required. These tasks will be further discussed in the upcoming sections.

Switching Circuitry: Different towers might have different number of critical points (multiple cables or multiple points per cable). Each sensory data, at a critical point, is considered as an analog input and acquiring each of these data points will require an Analog to Digital Converter (ADC) input. To accommodate the variability in the number of critical points used, we designed a switching circuit that functions as a multiplexer and is connected to a single ADC pin on the microcontroller. The microcontroller can then select which strain gage data to read.

Communication

To monitor the status of the tower, both during installation and throughout its operation lifetime, we need to communicate with the PU locally and remotely.

During installation and/or maintenance, and users can connect directly to the tower's PU to view the tension on the cables and consequently the towers vertical alignment. We use serial communication to establish this direct link.

Remote communication to RCMO is required because the towers are usually placed in very remote areas where local technicians are not always available. We connect each PU through a GSM modem to establish bidirectional remote communications between the RCMO and the PU. This communication is based on sending SMSs that could time and/or event triggered.

The PU sends messages to the RCMU at regular intervals set by the technician. It can also send messages that are triggered by events (e.g. exceeding an allowable strain on a guy cable or an allowable deflection of the tower.

Software Tools

We built software tools; one to help technicians during the on-site operations (installation and maintenance) and another to facilitate remote monitoring.

The *Local Monitoring Unit* (*LMU*) is used on-site and it shows the status of the tower (figure 6). The LMU displays current and historical strain values at each critical point and the calculated deflection of the tower. It continuously receives information from using the microcontroller serial port.

The second tool is the *Remote Monitoring Unit* (RMU). It is used to continuously monitor the tower status in the RCMO.

The RMU (figure 7) shows a map of the different towers placed at different locations. The information of all towers is stored in a database which facilitates simple interaction (deletion and search). Each tower is identified by a unique ID which is the GSM's number at the PU.

When installing a new tower in the field, the RMU operator can add a tower either graphically or by specifying the exact longitude and latitude on the map. The operator can then configure the different tower parameters specifying the number of guy cables, the tower's GSM modem phone number, and the time interval. The operator can zoom through the map into a specific tower to see its latest status or probe it for a new one.

Selecting a tower displays the detailed status of the tower including:

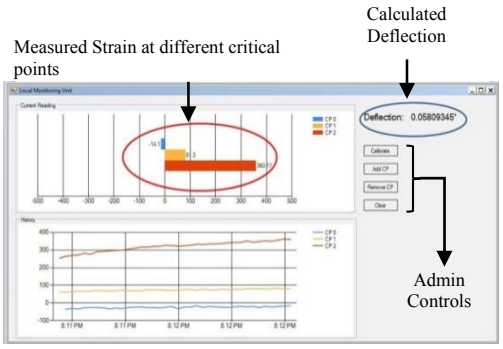


Figure 6: Local Monitoring Unit

Figure 7: RCMO showing towers spread on UAE map.

- The last message update received from the tower's processing unit
- History of messages received
- The warning level at the tower
- Tower's location

It also contains some admin controls such as:

- Requesting a new status update from processing unit
- Setting the time threshold for the time triggered messages
- Disabling/Enabling communication from the processing unit

Figure 8 shows a detailed tower status of a tower with 3 critical points during the period from 3/22/2012 to 3/30/2012.

V. Experimental Setup

For testing and verifying the system, a small tower model (figure 9) was built to simulate the real tower structure. The guy cables were modeled using steel strands. The tower mast was replaced by a rigid steel mast. Ball and socket structure was used to simulate the real tower structure of having a free point stand. Tension clamps were used to apply initial tension to the guy cables. Furthermore, the strain gauges were placed on the guy cables.

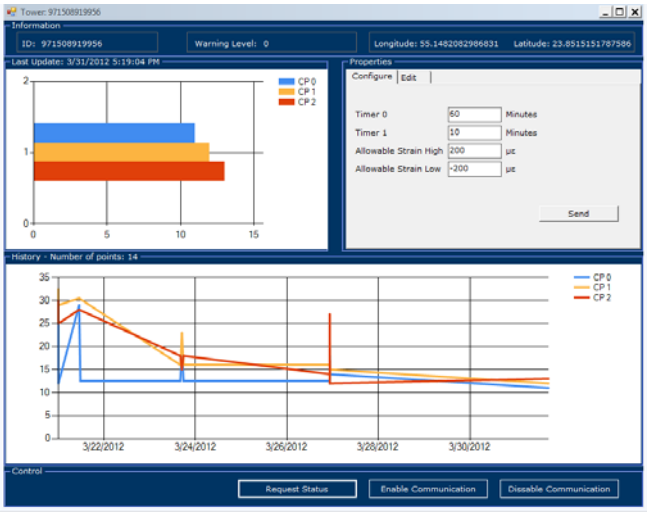


Figure 8: Detailed Tower Status

Test and results

To verify the strain readings from the strain gauges we applied different forces on the guy cables where the strain gauges were placed. Table 1 lists part of the test results of the applied force and actual strain compared to the strain measured using the gauges. The cumulative results show an average error of 3.4%.

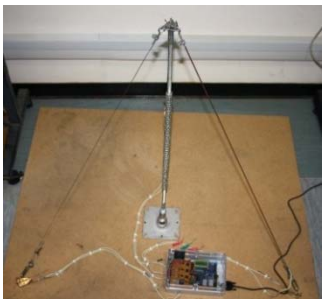


Figure 9: Tower Model

Table 1: Strain gauges test results

Force (N)	Measured strain (µ£)	Actual strain (µ£)	Error
100	-333.2222592	-333.333333	0.0333%
200	-666.2225183	-666.66666	0.0666%
250	-799.3605116	-833.333333	4.0767%
300	-1065.530101	-1000	6.5530%
350	-1165.307142	-1166.66667	0.1165%
387	-1364.801438	-1290	5.7986%
405	-1431.281829	-1350	6.0209%
450	-1564.216062	-1500	4.2811%

To calculate the tower's (mast) deflection we used force and geometrical analysis. We modeled our model tower in 3-dimentions (figure 10). The location of the tower top, where the mast and the guy cables intersect, is marked with

coordinates *(X,Y,Z)*. Each cable is numbered (1 to *3*), then the coordinates of the other end of each cable is marked by (x_i,y_i,z_i), where i is the cable's number. Accordingly, the following points are defined as shown in table 2:

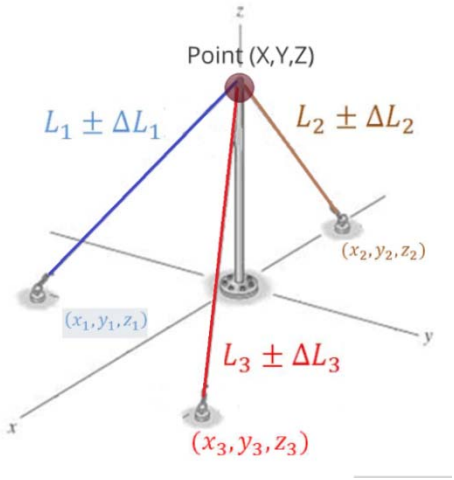


Figure 10: 3D tower representation

Table 2: Cable specifications

	Cable 1	Cable 2	Cable 3
Color	blue	brown	red
Start Point	(x_1,y_1,z_1)	(x_2,y_2,z_2)	(x_3,y_3,z_3)
Length	L_1	L_2	L_3
Tower top	Coordinate: (X,Y,Z)		

By knowing the strain at each guy cable, the stretching value (ΔL_i) can be determined. Furthermore, the point of intersection (X, Y, Z) of the cables with the mast can be found using the sphere equation as follows (Eq. (2), (3) and (4)):

Eq. (2): $$(X-x_1)^2+(Y-y_1)^2+(Z-z_1)^2=(L_1+\Delta L_1)^2$$

Eq. (3): $$(X-x_2)^2+(Y-y_2)^2+(Z-z_2)^2=(L_2+\Delta L_2)^2$$

Eq. (4): $$(X-x_3)^2+(Y-y_3)^2+(Z-z_3)^2=(L_1+\Delta L_3)^2$$

Moreover, the tower deflection can be calculated such that:

Eq. (5): $$Z=(Tower\ Height)\times\cos(deflection°)$$

Eq5 is on the assumption that the tower height doesn't vary much with expansion compared to the cables. To verify the calculation, different forces were applied to the mast; then the tower top displacement from its original position was measured (figure 11) where θ represents the angle of the deflection, and were compared to the results of the used equations.

The outputs of the real and measured displacement are shown in table 3. The empirical results show an average error of 9%.

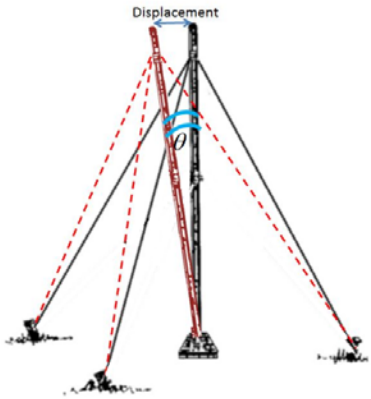


Figure 11: Tower Deflection
(Black: original position - Red: new position)

VI. Future Work

The next step after determining the status of the tower is to decide what to do. In our current system the RMU operator can dispatch a maintenance team to the tower's site in case a problem is detected.

An even better system can attempt to rectify the problem without the need to dispatch a maintenance team. The plan is use a motorized correction system that can be attached to a tower to tension or release the guy cables and help bring the tower back to a correct or safe position.

We plan to use the PU currently in place to issue the proper commands to the correction system which is an assembly of motors and gears.

VII. Conclusion

We propose a robust monitoring system for guyed towers used in the telecommunication infrastructure network. The proposed system provides a reliable solution that helps reducing tower failures due to poor installation or severe weather conditions. Furthermore, the new system prevents service disturbance due to environmental changes. The proposed system consists of a Processing Unit for each tower that reads, analyzes, and then transmits critical tower conditions through a GSM modem to a Remote Central Monitoring Office (RCMO). The PU gathers environmental information and cable tension measurements in a routine maintenance checkup and sends this information to the RCMO. The operator at the RCMO can inspect the status of each tower or probe the tower for its status. This can help predicting the possibility of a tower failure due to deflection, hence fixing the problem early enough, eliminating tower re-installation cost and maintaining uninterrupted service and improve the overall user experience.

Table 3: Deflection test results

Measured Displacement (mm)	Real Displacement (mm)	%Error
0.761577	0.8	5%
1.16619	1	17%
1.345362	1.3	3%
1.3	1.5	13%
2.051828	1.86	10%
2.408319	2.12	14%
2.692582	2.4	12%
2.236068	2.5	11%
2.61725	2.53	3%
3.162278	3	5%
7.283543	6.3	16%

REFERENCES

[1] M. Haider, The Impact of Network Downtime on Business Today, Networks First Limited, University of Warwick, 2007.

[2] http://www.globalsecurity.org/intell/library/policy/army/fm/24-18/fm24-18_4.htm. [Accessed February 2012]

[3] http://www.indiamart.com/automation-technology/products.html. [Accessed February 2012]

[4] http://mer-telecom.com/?CategoryID=281&ArticleID=126[Accessed March 2012]

[5] http://www.greatplainstowers.com/services/anchor_shaft_services.html [Accessed February 2012]

[6] NIOSH Alert: Preventing Injuries and Deaths from Falls during Construction and Maintenance of Telecommunication Towers, National Institute for Occupational Safety and Health.

[7] "Guyed Telecommunication Tower (HW)," [Online].Available: http://huawochina.en.madein-china.com.

[8] K. Andress, A study of what happens when we make changes to a tower configuration

Alternans-Arrhythmia: A Simulation Study Based on Invertebrate Heart Neurobiology

Toru YAZAWA

Neurobiology, Tokyo Metropolitan University, Tokyo, Japan (email: yazawa-tohru@tmu.ac.jp)

and

Hiroyuki KITAJIMA
Electric Engineering, Kagawa University, Takamatsu, Kagawa, Japan

ABSTRACT

Alternans is an arrhythmia exhibiting alternating amplitude/interval from beat to beat. Alternans is well known since Traube's document in 1872 and is called harbinger of death, but the mechanisms for its generation is not fully defined and much work still remains. We studied this abnormal state of the heart in animal models (electrophysiology) and with a numerical model (computer simulation). We focused our attention on a causal association between the pace-making cells and ventricular cells. We revealed that one of the main causalities in generating alternates was a potassium ionic abnormality.

Keywords: Alternans, EKG, Invertebrate heart, Potassium, Simulation, Sodium.

1. INTRODUCTION

A persimmon tree bears rich fruits every other year. Atmospheric oxygen on the earth has annual bistability [1, 2]. Period-2 is an intriguing rhythm in nature's environment. The alternans is also natural period-2 phenomena. Since the cardiac period-2 was described by Traube in 1872 (see ref [3]), alternans has still remained an electrocardiographic curiosity [4, 5].

In our physiological experiments on the crustacean hearts, we have noticed that alternans was frequently observable with the "isolated" hearts. It was a sign of future cardiac cessation. In fact, researchers believe that alternans is the harbinger for sudden death [4, 6]. Details of alternans have not been studied in crustaceans. But, we are sure that animal model studies contribute to the advance in management of the dysfunction of a complex cardiovascular disease.

In the worst case scenario alternans triggers a cardiac instability (e.g. ventricular arrhythmias) and causes a sudden cardiac death [4]. Reducing the risk of sudden death is a goal of research in physiology and technology, but mechanisms for the generation of alternans have not been fully defined. The cardiovascular system (CVS) of us humans and those of invertebrates resemble each other because of evolution. Our human system is fundamentally a copy of them. We thus tried to analyze alternans, using experimental data on animal models, with a newly assembled mathematical model by the authors [19]. Alternans computer simulation, based on the real-world crustacean data, has been little reported before.

2. MATERIALS AND METHODS

Heartbeat Recording

Ethics: All subjects were treated as per the ethical control regulations of the Tokyo Metropolitan University.

Human Heartbeat: We recorded the finger pulses with a piezoelectric sensor, connecting to a Power Lab System (PLab, AD Instruments, Australia). The PLab digitized data at 1 kHz.

Animal Heartbeat: We recorded the electrocardiogram (EKG) with metal electrodes. The EKG signals were amplified (10,000 times, DAM50-Amp, WPA, USA) and then sent to the PLab.

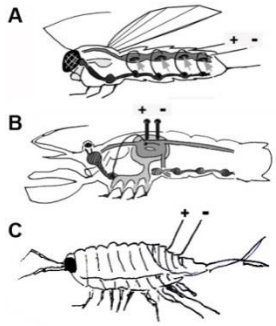


Fig. 1. EKG methods. A, insect; B, lobster/crayfish; C, *Ligia*

Intact Hearts (Animal Model): We recorded EKGs from following animals: The hornet, *Vespa* sp. (n = 17, Fig. 1A), the lobsters, *Homarus americanus* (n = more than 50, Fig. 1B), the crayfish, *Procambarus clarkii* (n > 100), and the sea lice, *Ligia exotica* (n = 3, Fig. 1C).

Isolated Heart (Animal Model): Fig. 2 shows an experimental set-up to potential (P) and force (F). A hanging glass capillary micro-electrode was used to record intracellular membrane potential of moving heart (P). The pace-maker cells (CG, Fig. 2) are located on the dorsal lumen of the ventricle. We opened the heart from ventral side to record pace-maker activities, using the extracellular recording methods (CG trace in Fig. 2). Force of contraction was recorded mechanically by a force transducer (F in Fig. 2). We also used isolated *ostium* muscle (*OOM, musculus orbicularis ostii*) to investigate E-C coupling of the heart muscle [7, 8].

Animal Heart Evolution

The human heart develops from the beating tubes. Folding-tube is a key process to make a chambered heart (Fig. 3, C1, C2, and C3). A vertebrate gene, *Nkx2-5*, works for the heart development (Fig. 3). A fly gene, *timnan*, which is an orthologue gene (or homologous gene) of *Nkx2-5*, works for a fly tube heart (Fig. 3A). In turn, the lobster has a chambered heart (Fig. 3D). Evolutional link between the tube-heart and the chamber-heart is shown in Fig. 3B: A hypothetical evolutional link from *Squilla* heart to *Homarus* heart [9]. Existence of the hereditary trait indicates that crustacean hearts and human hearts are fundamentally the same, in terms of morphology and physiology: a pump with a controller.

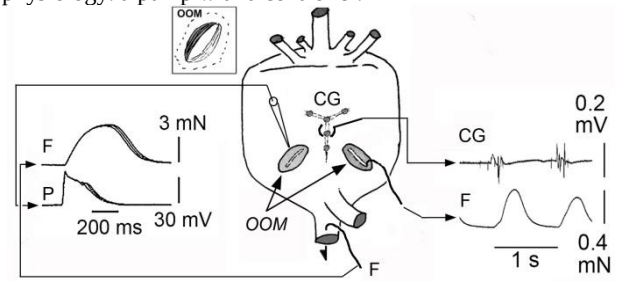


Fig. 2. Isolated heart experiments. Recordings of muscle action potential (P), force of contraction (F), and extracellular recording of the cardiac ganglionic pacemaker impulses (CG). Homarus heart, ventral view. The CG is attached to the dorsal lumen of the heart, therefore the CG can be seen, if the heart is opened. Inset, an isolated ostium, *OOM* (*musculus orbicularis ostii*) (see [7, 8]).

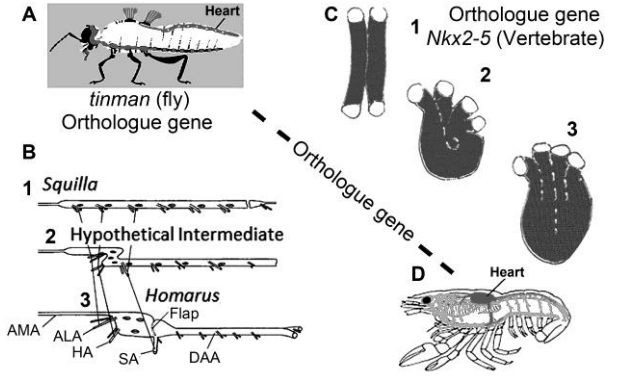


Fig. 3. Evolution of the heart: Link between arthropods and vertebrates. AMA; anterior median artery; ALA, anterior lateral artery; HA, hepatic artery; SA, sternal artery; DAA, dorsal abdominal artery.

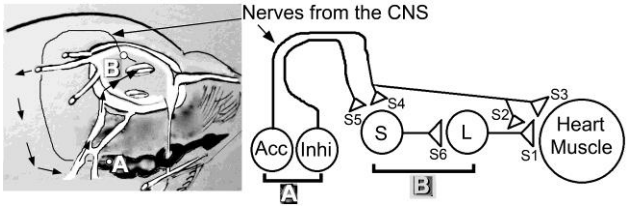


Fig. 4. Crustacean cardio-regulatory system. Arrows indicate the direction of blood flow: Leaving from the heart, passing through arteries, body cavity, gills near legs, pericardial sinus, and ostia to return to the heart. The central nervous system (CNS) (A) sends autonomic nerve fibers to the pace-maker (B) and the heart muscle [12]. Postulated neurotransmitters working at synapses are: S1, S2, S3, S4: glutamate [10, 11, 12]. S5: GABA [12]. S6: acetylcholine [13].

Heartbeat Regulation

To adjust to peripheral demands and to propel blood efficiently, the heart needs to receive controls. The cardiac control center is located in the sub-esophageal ganglion (A in Fig. 4). This center is homologous to the human autonomic brain center for the heart. In crustaceans, the center (A) sends two types of nerves to the heart: acceleratory and inhibitory axons (see the nerve-circuit diagram in Fig. 4). The cardio-regulatory nerves innervate both the pace-maker (B) and the heart muscle. B is composed of small-sized pace-maker cells (S) and large-sized pace-maker cells (L). The muscle cells receive periodic stimuli from L. B is called as the cardiac ganglion (CG) (see CG in Fig. 2). B also works as a switch board or a relay circuit, transferring central commands to heart muscle. Heart muscles send feedback information to the CG [15]. In human, the heart has "the cardiac ganglions/plexus." The structure and function of the heart-control network of invertebrates are similar to that of vertebrates. Fundamental architecture is hereditable in evolution: a pump with a controller.

Six types of identified chemical synapses (S1 to S6) in the network have been fully documented (Fig. 4). In the present paper, we focus only on the synapse S1 among them. The synapse S1 connects L to muscle. We investigated this connection, focusing attention on the mechanisms of alternans arising in the L-S1-Muscle system.

3. RESULTS

Alternans is observable in human patients with heart failure. Alternans is thought as the harbinger of sudden death because alternans is known to advance to the state of fibrillation. Therefore, alternans could be a terminal sign, but much work remains to do. When and what conditions does the heart exhibit alternans?

Empirical Alternans

Animal Model: We recorded alternans from animals, insects and crustaceans. Alternans occurred hours before specimens passed away.

In insects (we tested 16 hornets *Vespa mandarinia* and *Vaspa crabro*, 13 bumblebees, *Bombus ardens*, five large carpenter bees, *Xylocopa appendiculata*, and two dragonflies, *Anotogaster sieboldii* and so forth), alternans phenomena were confirmed (example Fig. 5) if EKG electrodes were properly inserted (quick enough, i.e., almost no bleeding) (see Fig. 1 for recording methods, specimens immobilized).

In crustaceans (*Ligia exotica*, see Fig. 1C), alternans was also observable (Fig. 5): alnternans appeared before heart rate dramatically increased. Then, specimens died after EKG gradually became small in amplitude. We observed such alternans phenomena in many crayfishes, many lobsters (*Pnulirus japonicas*, *Homarus americanus*), and crabs (the coconut crab *Birgus latro* n = 4, the mokuzu crab *Eriocheir japonicas* n = 3, and the saw tooth gazami crab *Scyll serrate* n = 2).

Human Subjects: Fig. 6 shows human period-doubling bifurcations. We can see not only two beats (Fig. 6C dashed line) but also four beats (see dots in Figs. 6B and 6C). We so far did not observe eight beats pumping.

Contraction and Potassium: Amplitude of EKG-swings decreased over time while dying. This decrease in amplitude reflects gradual depolarization of muscle cells: the more membrane depolarize, the more amplitude decrease, and the more heart rate increase. Human terminal patients such as a cancer patient show the same phenomena. In other words, an increased heart rate exhibits edema-swelling symptom at a terminal condition. The edema-swelling is caused by necrosis of cells in various organs: caused by potassium leaking from the dead cells to extracellular space (K^+ is essential for many physiological processes and must be concentrated in all living cells [24]). The cell death can happen at various terminal conditions. Alternans is a gateway to the terminal state. However, heart rate in Fig. 6 is not extremely high (heart rate, 60-80). Therefore, she can be alive over five years since this recording was taken.

In conclusion, these intact heart results suggest that necrosis-induced depolarization at the terminal condition caused alternans. We thus confirmed that alternans is a terminal sign as previously pointed out since Traube (1872) (see ref [3]).

Arousal Alternans: In Fig. 7, heart rate dramatically increased and alternans appeared during a high rate beating (←→indicate alternans): here, a "sleeping" crayfish "woke up" going on an "arousal state". We observed as much as > 50 alternans per hour from this crayfish, within a continuous 37 hr EKG recording. Alternans appeared at maximum speed of beating, induced by the cardio-acceleratory nerves. We converted Fig. 7A data to Fig. 7B with "100 millisecond delay-time embedment" (see Takens [14]). This map (a Poincaré map) clearly shows two distinctive alternate pulses. The tails of orbit of large contractions are unstable/wobbly (Fig. 7B arrowhead), indicating that termination of muscular action potential by potassium current (Hodgkin and Huxley theorem) was unstable. Instability of reversal potential of potassium ions is perhaps involved. This alternans is not a terminal sign, because amplitude of EKG is large in swing size (i.e., hyperpolarization instead of depolarization, see Fig. 5). The cardiac nerves contribute to the induction of this alternans. Hormones also contribute. Therefore, signal molecules are key inducers. In conclusion, neurotransmitters and hormones affect membrane depolarization, membrane excitation (spike-generation), calcium (Ca^{2+}) handling [i.e., (1). extracellular Ca^{2+}, (2) intracellular Ca^{2+}, (3) ryanodine receptor efficiency, and (4) endoplasmic-reticulum (ER) Ca^{2+} amount]. Unknown mathematical mechanisms work to link nonlinearly all elementally processes.

Isolated Muscle Alternans: We isolated *OOM* (see Fig. 2) and stimulated *OOM* every 1 to 2 sec (field stimulation with platinum (Pt) electrodes) and measured membrane potential (E) and force (F) of contraction (Fig. 8, inset). Bath application of a crustacean cardio-active neurohormone (proctolin, 10^{-9} mol/L, perfused for 2 min from an arrowhead) induced depolarization, and augmentation of stimulus-induced contractions (Fig. 8A). Proctolin can induce spontaneous membrane oscillation and cyclic contraction (Fig. 8B). Period doubling (BPM trace) but less noticeable amplitude alternans (mV trace) can be seen. Signal molecules, such as proctolin and FMRF-amid like crustacean cardio-active peptide, often induced similar oscillation and alternans (data not shown). This isolated muscle experiments indicated that muscle itself has ability to generate spontaneous alternans without regular cyclic timing signals.

Remarks for Empirical Results: Physiological tests are not enough for understanding complex causal connection behind alternans induction. We tried simulation study based on model animals' physiology data.

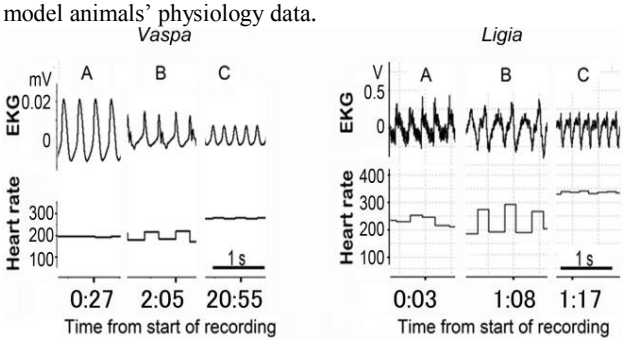


Fig. 5. EKGs of the hornet, *Vespa* sp. and the sea lice, *Ligia exotica*). *Vespa*: A, normal regular beating 27 min after start of recording (insect's anti-peristaltic beating, not referred to in this article). B, period-2, two hours after start of recording. C, heart rate dramatically increased, 20 hours. The heartbeat disappeared one min. after this recording. *Ligia*.: A, regular heartbeat, three min. after start of recording. B, period-2, one hour. C, heart rate dramatically increased. The heartbeat disappeared two min after this recording.

Alternans Simulation

Mathematical Models: Studies of alternans using mathematical models are important for reducing the risk of sudden death. Previous modeling studies used difference equations for modeling alternans: revealing that generation of alternans is related to the period-doubling bifurcation or the border-collision bifurcation [16]. More realistic models using partial differential equations are proposed: revealing the dependency of [K]o (extracellular concentrations of potassium ions) [17] and influence of ionic conductance on alternans [18].

Human ventricular muscle cells receive excitatory stimulus from the pacemaker cells. Shape of the signals is characterized by a unique potential shape, that is, the diastolic slow depolarization (for an example, see Fig. 8B, mV-trace). However, in the previous modeling studies, the shape of stimulus was a rectangular wave. The coupling scheme from the pacemaker cells to the ventricular cells was not incorporated into these modeling. In contrast, we (Fig. 9A) used real synaptic potential shape [7] for modeling [19].

The network structure of the heart and nerves is known (see Fig 4).The identified synapse is S1 (see Fig. 4, from L to muscle), which is the target synapse in the present paper. We considered S1 is a key element in the L-S1-muscle architecture [7].

In the present paper, we used a simpler model, which has been previously published as the congress papers [19, 20]. The previous publications were lacking detailed consideration about the rationality between empirical real-world data and numerical simulation data. We demonstrate here the evaluation of our challenge of simulation by presenting real-world data as abovementioned.

By numerical analysis of our model we obtained results that two parameters (the conductance of the sodium ion and concentration of the potassium ion in the extracellular space) play key roles of generating alternans (see below).

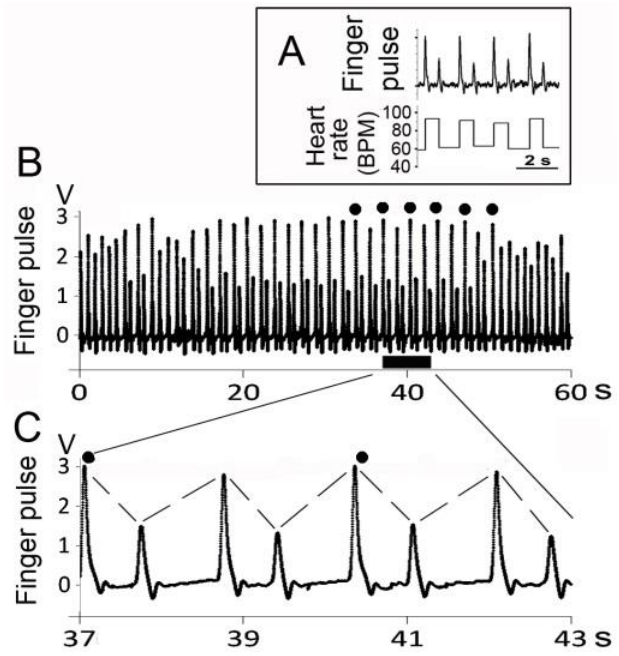


Fig. 6. Human alternans. A patient who suffered a cancer, diabetes, and kidney problems. Female age 60s. A wife of an author's (TY) friend kindly and willingly gave us her pulses.

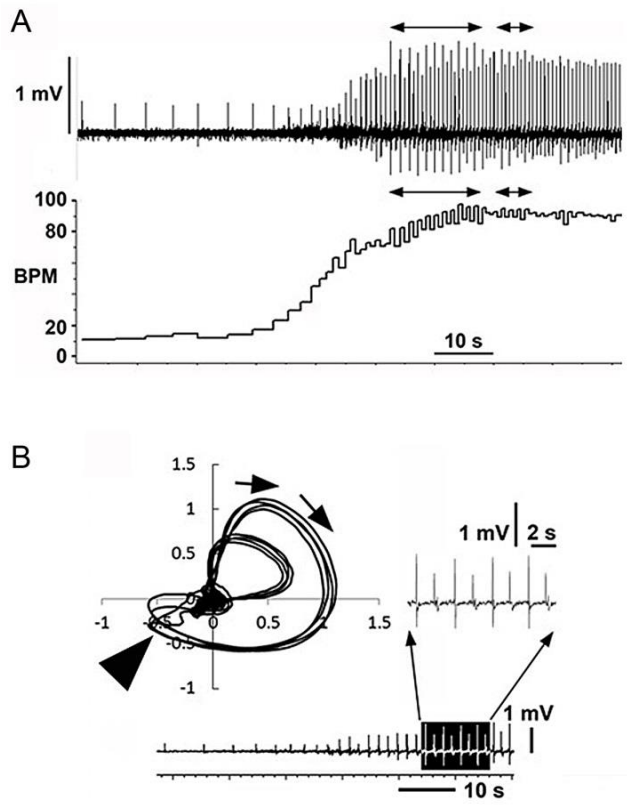


Fig.7 Crayfish alternals. A, during arousal behavior. B, Phase-space representation of Fig. 8A. One-second delay time embedment [see 14].

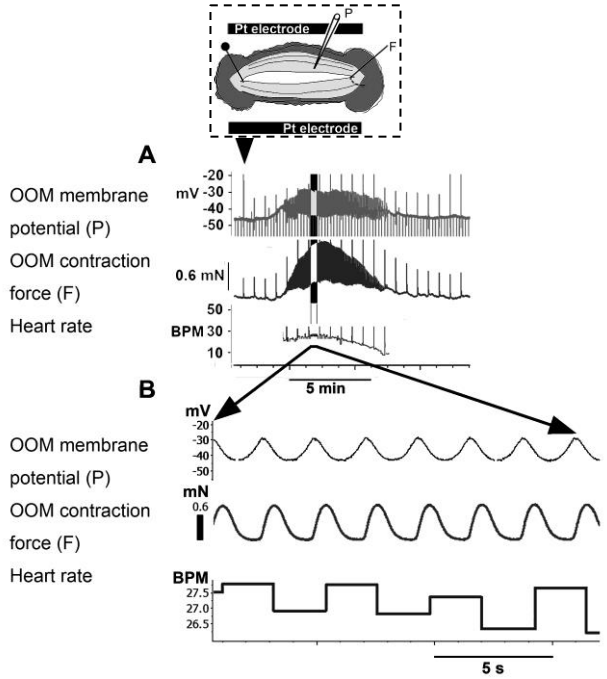


Fig. 8 Lobster *OOM* isolated muscle experiments.

LR Model with Synaptic Current: In Fig. 4 diagram, we only considered the sub-network of the pacemaker to the muscle cell (i.e., L-S1-muscle), as the first step of our study. For L and muscle we used the YNI model (Yanagihara-Noma-Irisawa) [21] and LR I model (Luo-Rudy I) [22] model, respectively. We treated L as the pacemaker cell. Considering the synaptic current from the pacemaker cell to the muscle cell, the dynamics of the pacemaker cell do not affect that of the muscle cell. Thus in this study we only consider the muscle cell with a periodic force. The period of the external force (usually called BCL: basic cycle length) is assumed to be 380 [msec]. The membrane potential V of the LR model with the synaptic input is described by

$$C\frac{dV}{dt} = -(I_{Na} + I_{Ca} + I_K + I_{K_1} + I_{Kp} + I_b + I_{syn}) \quad (1)$$

where the meaning and the equations for each current is given in Appendix. *C* is the membrane capacitance. The synaptic current *Isyn* from L to the muscle cells is given by

$$I_{syn} = G_{syn}(V - V_{syn})s(t^*) \quad (2)$$

where *Gsyn* is the maximum synaptic conductance, *Vsyn* is the reversal potential and the gating variable for the synapse *s(t*)* is assumed to be given by

$$s(t^*) = \frac{\tau_1}{\tau_2 - \tau_1}\left(-\exp\left(-\frac{t^*}{\tau_1}\right) + \exp\left(-\frac{t^*}{\tau_2}\right)\right) \quad (3)$$

where τ_1 and τ_2 are the raise and the decay time of the synapse, respectively. We identified these value 18 ms and 288 ms, respectively, from the experimental data (see Fig. 9A). We adjusted this crustacean values to mouse model. In mouse model, BCL is 1200 ms. Crustacean BCL was 380 ms in the present model. Thus, our two values for τ_1 and τ_2 are now 5.5 and 90, respectively (see Fig. 9A). t^* is the time which is reset at every nT (n is an integer and T is BCL).

Approximation of Discontinuous Functions: In Eq. (1), I_{Na} and I_K are given by

$$I_{Na} = G_{Na}m^3hj(V - E_{Na}), \quad I_K = G_K XX_i(V - E_K)$$

where E_{Na} and E_K are the reversal potential, G_{Na} and G_K are the maximum ionic conductance for sodium (Na^+) and potassium (K^+) current, respectively, and *m, h, j,* and *X* are given by

$$\frac{dy}{dt} = \frac{y_\infty - y}{\tau_y}, (y = m, h, j, X) \quad (4)$$

$$\tau_y = \frac{1}{\alpha_y + \beta_y}, y_\infty = \frac{\alpha_y}{\alpha_y + \beta_y}. \quad (5)$$

Here, α_j, β_j, α_h, β_h, and X_i are described by discontinuous functions. For example, β_j and X_i are given by

for V ≥ -40

$$\beta_j(V) = \frac{0.3 \cdot \exp(2.535 \cdot 10^{-7} V)}{1 + \exp\{-0.1(V+32)\}} \quad (6)$$

for V < -40

$$\beta_j(V) = \frac{0.1212 \cdot \exp(-0.01052 V)}{1 + \exp\{-0.1378(V+40.14)\}} \quad (7)$$

for V > -100

$$X_i(V) = \frac{2.837 \cdot (\exp\{0.04(V+77)\} - 1)}{(V+77) \cdot \exp\{0.04(V+35)\}} \quad (8)$$

for V ≤ -100

$$X_i(V) = 1.0. \quad (9)$$

Considering a large number of neurons, discontinuous functions switched by some threshold values are not suitable for bifurcation analysis, because the algorithm becomes complicated. We adopted the continuous functions version of the Luo-Rudy model using sigmoidal functions. For example, β_j (V) in Eq. (6) and (7) were combined into one equation.

$$\beta_j(V) = \text{Eq.}(6) \cdot 0.5(1 + \tanh\{100 * (V + 40)\}) + \text{Eq.}(7) \cdot 0.5(1 + \tanh\{-100 * (V + 40)\}). \quad (10)$$

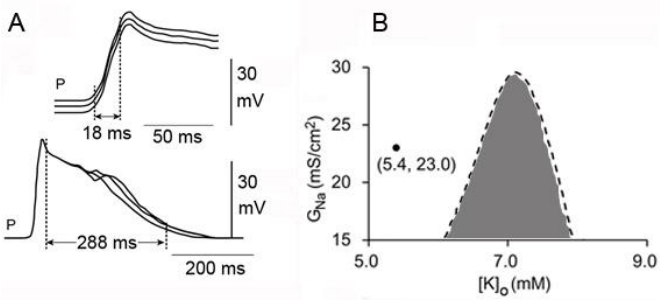


Fig. 9. A, configuration of the synaptic potential (recording methods, see Fig. 2). B, simulation, $[K]_o$ vs. G_{Na}.

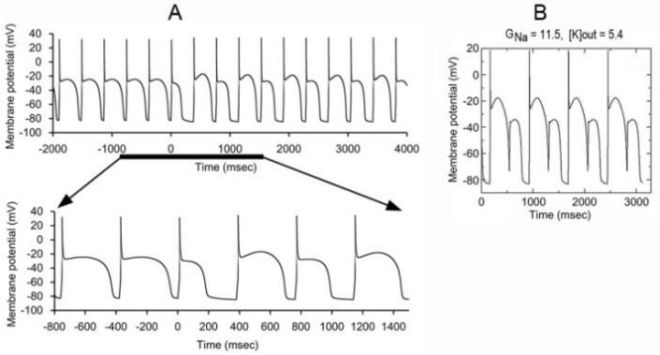


Fig. 10. Alternans simulation. A, period-doubling bifurcation. At time zero, $[K]_o$ was switched from 5.4 (normal) to 7.0 (edema). B, The saddle-node bifurcation but not alternans

Simulation Results

We have already shown the effectiveness of the approximation (Eq. (10)) [20]. The approximation worked well and we observed periodic solutions [20]. We studied bifurcation phenomena correlated to alternans in the model. The value of the parameter related with are fixed as *Gsyn* = 4.0, *Vsyn* = -29. Fig. 9B shows a two-parameter bifurcation diagram on the parameter plane $[K]_o$ (extracellular concentrations of potassium ions) and G_{Na} (the conductance for the sodium current). In this parameter region we observed two types of periodic two-periodic solutions, the period-doubling bifurcation and the saddle-node bifurcation [20]. The period-doubling bifurcation was alternans (Fig. 9B in gray region, Fig. 10A). Simulation spikes (Fig. 10A) apparently resembles with physiological spikes. The saddle-node bifurcation was not alternans (at G_{Na} below 12 mS/cm^2, scale out in Fig. 9B, see Fig. 10B an example trace).

Fig. 9B shows the area of the period-doubling. The closed circle (5.4, 23.0) indicates normal blood condition, i.e., the original values of the parameters. This simulation results indicate that alternans can be generated within a certain rage of extracellular potassium concentration, from 6 to 8 if G_{Na} is fixed to 15. With a normal G_{Na} (23.0), alternans can be induced only at $[K]_o$ around 7 mM.

If $[K]_o$ increased from normal value 5.4 to up high, according to the Nernst equation (see Appendix, E_{K1}), we can predict that the equilibrium potential shift toward depolarizing direction. The more K^+ leaks, the more membrane depolarizes.

Empirical data (Fig. 2) suggested that excessively developed necrosis symptom does not exhibit alternans. (see Fig. 2, *Vaspa* C and *Liga* C). The simulation supported our physiological explanation why alternans disappear at a terminal state. We can explain it is due to a high value of potassium in tissue fluid. Simulation result was understandable and thus successful in the present analysis.

4. DISCUSSION

In this paper we investigated the mechanism of generating alternans in the single model with the synaptic current. In most of previous studies the control parameter for generating alternans was period of an external stimulus modeled by an ideal pulse wave [23]. However, we considered that, for better simulation, ideal shape would be a shape resembling to the real signal shape from the pacemaker cell to the muscle cell in the real heart. Our model based on experiment and the input to the muscle cell has a real shape, measuring the synapse from the pacemaker cell (Fig. 9A). Thus, in our model, the timing and the amplitude of synaptic inputs depend on the membrane potential of the pacemaker cell and the muscle cell, respectively.

In our model, we obtained alternans even though the period of stimulus is unchanged; the pacemaker cell is normal. We chose the several ionic conductances as control parameters. Thus, we could study the mechanism of generating alternans caused by problems such as channelopathies in the muscle cell. We found that free concentration of the potassium ion in the extracellular compartment ($[K]_o$) and the sodium ionic conductance are key parameters to generate alternans. $[K]_o$ affects several other parameters. We studied all of them and found that E_{K1} (the reversal potential for the time-independent potassium current) is the most important parameter correlated with $[K]_o$. Usually the change of E_{K1} only affects the value of the resting membrane potential. However, in this study, we found that the alternating oscillations suddenly appear by a slight increase of E_{K1}.

Extracellular potassium and membrane sodium conductance were key factors for generating alternans (Figs. 9B and 10). An interesting discovery from the present simulation was that alternans was observable only in limited area of simulation plane (Fig. 9B). Too high value of $[K]_o$ suppressed alternans. This is of interest because this finding explains the dying condition of many animals (for example Fig. 5, *Vaspa* and *Ligia*). Edema is one of serious sick state, which accompanies a high heart rate such as the case of a terminal cancer patient. Our simulation can explain this terminal condition. If we observe alternans, we must check whether or not K^+ and/or Na^+ take abnormal values.

It was the first observation of relationship between alternans and the value of both the sodium ionic conductance and the potassium reversal potential. From the biological aspect, an amount of the sodium ion and the potassium ion are controlled by the kidneys. Very sick patients, such as terminal cancer patients, retain a lot of K^+-leakage from damaged live cells in various organs. This state would worsen the state of the kidneys. Heartbeat checking could be an early warning technology.

Our open problems are as follows: (1) studying the whole network (Fig. 4), (2) investigating calcium dynamics of myocardium. The latter problems are currently under investigation by various researchers (see ref [20]).

5. ACKNOWLEDGEMENT

This work was supported in part by a Grant-in-Aid for Scientific Research No. 23500524 (TY) and No. 23500367 (HK). TY thanks DVX Inc. Tokyo, Japan, for the research support, No. 4DQ404 and No. DQ401.

6. REFERENCES

[1] C. Goldblatt, T. M. Lenton and A. J. Watson. "Bistability of atmospheric oxygen and the great oxidation." **Nature,** Vol. 443, 2006, pp. 683-686.

[2] Y. Kawatani and K. Hamilton. "Weakened stratospheric quasibiennial oscillation driven by increased tropical mean upwelling." **Nature,** Vol. 497, 2013, pp. 478–481.

[3] A. A. Conti. "Nineteenth century "Traube's pulse" and current "Cardiac alternans": significant features in the history of cardiology. **La Clinica Terapeutica.** Vol. 163, 2012, pp. e71-72.

[4] D. S. Rosenbaum, L. E. Jackson, J. M. Smith, H. Garan, J. N. Ruskin and R. J. Cohen. "Electrical alternans and vulnerability to ventricular arrhythmias." **N. Engl. J. Med.,** Vol. 330, 1994, pp. 235–241.

[5] B. Surawicz and C. Fisch. "Cardiac alternans: diverse mechanisms and clinical manifestations." **J. Am. College Cardiology,** Vol. 20, 1992, pp. 483-99.

[6] B. Pieske and J. Kockskämper. "Alternans goes subcellular. A "disease" of the ryanodine receptor?" **Circulation Res.,** Vol. 91, 2002, pp. 553-555.

[7] T. Yazawa, J. L. Wilkens, M. J. Cavey, H. ter Keurs and M. J. Cavey. "Structure and contractile properties of the ostial muscle (musculus orbicularis ostii) in the heart of the American lobster." **J. Comp. Physiol. B.,** Vol. 169, 1999, pp. 529-537.

[8] T Shinozaki, J Wilkens, T Yazawa, M Miura and H. ter Keurs. "Excitation-contraction coupling in cardiac muscle of lobster (Homarus americanus); the role of the sarcolemma and sarcoplasmic reticulum." **J. Comp. Physiol. B.,** Vol. 172, 2002, pp. 125-136.

[9] J. L. Wilkens, T. Yazawa, and M. J. Cavey. "Evolutionary derivation of the American lobster cardiovascular system an hypothesis based on morphological and physiological evidence." **Invertebrate Biol.,** Vol. 116, 1997, pp. 30-38.

[10] A. Sakurai, A Mori and H Yamagishi. "Glutamatergic neuromuscular transmission in the heart of the isopod crustacean Ligia exotica." **J. Exp. Biol.,** Vol. 201, 1998, pp. 2833–2842.

[11] T. Yazawa, K. Tanaka, M. Yasumatsu, M. Otokawa, Y. Aihara, K. Ohsuga and K. Kuwasawa. "A pharmacological and HPLC analysis of the excitatory transmitters of the cardiac ganglion in the heart of the isopod crustacen, Bathynomus doederleini." **Can. J. Physiol. Pharmacol.,**Vol. 76, 1998, pp. 599-604.

[12] T. Yazawa and K. Kuwasawa. "Dopaminergic acceleration and GABAergic inhibition in extrinsic neural control of the hermit crab heart." **J. Comp. Physiol. A.,** Vol. 174, 1994, pp. 65-75.

[13] T. Yazawa and K. Kuwasawa. "Intrinsic and extrinsic neural and neurohumoral control of the decapod heart." **Experientia,** Vol. 48, 1992, pp. 834-840.

[14] F. Takens. "Detecting strange attractors in turbulence." **Lecture Notes in Mathematics**, 1981, pp. 366-381.

[15] A. Sakurai and J. L. Wilkens. "Tension sensitivity of the heart pacemaker neurons in the isopod crustacean Ligia pallasii." **J. Exp. Biol.,** Vol. 206, 2003, pp. 105-115.

[16] C. M. Berger, X. Zhao, D. G. S., Hana M. Dobrovolny, Wanda Krassowska, and Daniel J. Gauthier. "Period-doubling bifurcation to alternans in paced cardiac tissue: crossover from smooth to border-collision characteristics." **Phys. Rev. Lett.,** Vol. 99, 2007, 058101.

[17] H. Arce, A. López and M. R. Guevara. "Triggered alternans in an ionic model of ischemic cardiac ventricular muscle." **Chaos**, Vol. 12, 2002, pp. 807–818.

[18] S. Bauer, G. Röder and M. Bär. "Alternans and the influence of ionic channel modifications: Cardiac three-dimensional simulations and one-dimensional numerical bifurcation analysis." **Chaos,** Vol. 17, 2007, 015104.

[19] H. Kitajima, and T. Yazawa. "Analysis of a cardiac mathematical model for suppressing alternans." **IEICE technical report. Nonlinear problems,** 2010, pp. 61–64. (Japanese)

[20] H. Kitajima and T. Yazawa "Modified Luo-Rudy model and its bifurcation analysis for suppressing alternans." International Symposium on Nonlinear Theory and its Applications, Kobe, Japan, September 4-7, **Proc. NOLTA**, 2011, pp. 390-393.

[21] K. Yanagihara, A. Noma, and H. Irisawa. "Reconstruction of sinoatrial node pacemaker potential based on the voltage clamp experiments." **Jpn. J. Physiol.,** Vol. 30, 1980, pp. 841–857.

[22] C. H. Luo and Y. Rudy. "A model of the ventricular cardiac action potential. Demoralization, repolarization, and their interaction." **Circ. Res.,** Vol. 68, 1991, pp. 1501–1526.

[23] R. Thul and S. Coombes. "Understanding cardiac alternans: A piecewise linear modeling framework." **Chaos,** Vol. 20, 2010, 045102.

[24] R. S. Vieira-Pires, A. Szollosi and Joaˆo H. Morais-Cabral. "The structure of the KtrAB potassium transporter" **Nature,** Vol. 496, 2013, pp. 323–328.

7. APPENDIX

Ionic currents in Eq. (1) are given by

$$
\begin{aligned}
I_{Si} &= G_{Si} df (V - E_{Si}), \quad \text{(slow inward current)},\\
I_K &= G_K XX_i (V - E_K), G_K = 0.282\sqrt{[K]_o/5.4},\\
&\quad E_K = \frac{RT}{F}\ln\left(\frac{[K]_o + PR_{NaK}[Na]_o}{[K]_i + PR_{Nak}[Na]_i}\right),\\
&\quad \text{(time-dependent potassium current)},\\
I_{K_1} &= G_{K_1} K_{1_\infty} (V - E_{K_1}), G_{K_1} = 0.6047\sqrt{[K]_o/5.4},\\
&\quad E_{K_1} = \frac{RT}{F}\ln\left(\frac{[K]_o}{[K]_i}\right),\\
&\quad \text{(time-independent potassium current)},\\
I_{Kp} &= 0.0183 Kp(V - E_{Kp}), \quad \text{(plateau potassium current)},\\
I_b &= 0.03921(V + 59.87), \quad \text{(background current)}.
\end{aligned}
$$

Detailed explanation of these equations: see Luo-Rudy I model.

Development of a Web Application: Recording Learners' Mouse Trajectories and Retrieving Their Study Logs to Identify the Occurrence of Hesitation in Solving Word-Reordering Problems

Mitsumasa ZUSHI
Graduate School of Informatics, Shizuoka University
Hamamatsu, Shizuoka Prefecture 432-8011, Japan

and

Yoshinori MIYAZAKI
Graduate School of Informatics, Shizuoka University
Hamamatsu, Shizuoka Prefecture 432-8011, Japan

and

Ryosuke MIKI
Graduate School of Informatics, Shizuoka University
Hamamatsu, Shizuoka Prefecture 432-8011, Japan

and

Ken NORIZUKI
School of Information Studies, Shizuoka Sangyo University
Fujieda, Shizuoka Prefecture 426-8668, Japan

ABSTRACT

Most computer marking systems evaluate the results of the answers reached by learners without looking into the process by which the answers are produced, which will be insufficient to ascertain learners' understanding level because correct answers may well include lucky hunches, namely accidentally correct but not confident answers. In order to differentiate these lucky answers from confident correct ones, we have developed a Web application that can record mouse trajectories during the performance of tasks. Mathematical analyses of these trajectories have revealed that some parameters for mouse movements can be useful indicators to identify the occurrence of hesitation resulting from lack of knowledge or confidence in solving problems.

Keywords: e-learning, Mouse Trajectory, Study Logs, Information Retrieving Tool, Occurrence of Hesitation.

1. INTRODUCTION

Based on the supposition that answers being correct or incorrect alone may not be a true reflection of the learners' understanding unless the processes of the learners' responses are carefully considered, we have been developing a Web application which will enable both teachers and learners to notice the crucial aspects of "uncertainty" or "hesitation" in producing answers resulting from learners' lack of confidence or knowledge. Through the analyses of our former experiments, where learners were asked to solve word-reordering problems (WRPs) by dragging and dropping the given words with the mouse, we have verified the possibility for several parameters for mouse movements showing hesitation or uncertainty, to detect the difficult problems for a group of learners as a whole.

In this paper, we first describe our Web application briefly, and then find the norms of mouse trajectories for correct and confident answers, and compare the norms with mouse trajectories included in the answers of which learners are not certain or confident, in order to investigate whether or not there are any significant differences between them. Since confident and correct answers will show smooth mouse movements in placing the words in the right position, these differences will be the clues for detecting unnecessary movements in answering WRPs, which, we hypothesize, will deeply connect with learners' uncertainty and lack of knowledge or confidence. We also suggest probable ways to apply the "differences" from the norms to identify hesitation or uncertainty in individual learners' solving process of each problem in order to detect which part or words are difficult for a particular learner to reorder and produce a correct answer.

2. RELATED RESEARCH

There have been several studies dealing with study logs or mouse movements so that teachers or administrators would be able to know users responses during their task performance. In order to develop an authentication system, Tateda, et al. illustrated a number of technical properties of learners' mouse movements [1]. Ohmori, et al. investigated mouse behavior in the course of learners' reading task, classifying learners' reading habits into three patterns [2]. Arroyo, et al. created a

web logging system that helps website administrators check usability and analyze the collected data [3]. Ikegami scrutinized the learners' study habits from the logs and suggested effective learning environment [4], [5]. Developing their own software package called "MouseTracker," Freeman and Ambady enabled teachers to monitor subjects' behaviors during a psychological task, with the mouse trajectories being visualized in real time [6]. Nakamura, et al. analyzed facial movements in order to know the difficulty/easiness of the e-learning problems the learners solved [7], and Horiguchi, et al. developed a system that can presume learners' state of mind during the course of e-learning tasks by analyzing their facial responses and mouse speed [8].

Though featuring the analysis of study log and mouse movements, these studies have not analyzed the processes of learners' solving problems, as discussed in Miyazaki, et al. [9] and Zushi, et al. [10], which, the present authors believe, are the potential clues to ascertain learners' understanding levels.

3. WEB APPLICATION

In order to achieve our goal, we have been developing software that has three modules with independent, but also interrelated functions: 1) Study Module, which requires learners to perform word-reordering tasks by "dragging and dropping" each word into the appropriate position in a sentence, simultaneously recording all the mouse trajectories as well as the timing of drag-and-drops (D&Ds) in answering the problems; 2) Problem Construction Module, where teachers construct and add new problems on their own, or change marking scales from the default form; and 3) Retrieval & Analysis Module, which reproduces all the actions recorded in the learners' mouse trajectories, and analyzes the data from the diverse patterns of the study logs both from the learners' and problems' perspectives. This software, consisting of three modules, has been programmed using PHP, Visual Basic, and MySQL.

Study Module
In WRPs, learners are required to make an English sentence from given words, one with a meaning equivalent to the sentence provided in the learners' native language. This type of problem has been and is even now a popular means in Japan to measure learners' knowledge of grammatical items, sentence structure, idioms/idiomatic phrases, and usages--the command of which is essential for producing correct sentences. Since Japanese is a synthetic language, it has quite a loose word order, while in an analytic language like English, word ordering has a crucial importance to decide the meaning of the sentence, its grammaticality, and acceptability. This is why Japanese novice or poor learners of English have difficulty in making a correct English sentence, and WRPs are effective in confirming the ability needed to produce English sentences.

The words to be rearranged are given in the "problem slot," and all the words should be moved into the "answer slot" by D&Ds with the mouse. All mouse movements (click, drag, drop, and their timing) for solving problems are recorded here (see Figure 1).

It is required for learners to press the OK button to finish answering, and then they rate their confidence in the answers on a pull-down, four point scale. After all these procedures are completed, the answers are automatically evaluated by the system.

In order to facilitate learners' performing the tasks, this module has the following functions:

1) Word groupings: an arbitrary number of words can be grouped together by mouse-dragging (rectangular selection) if it is convenient for learners to treat them together, and
2) Relocation to registers: areas called "registers" are provided as a temporary "shelter" for words, where a set of words can be integrated into meaningful segments if it is preferred for learners to organize their ideas.

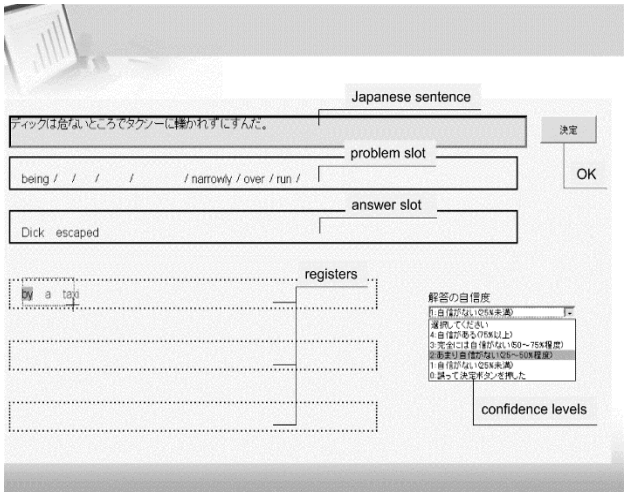


Figure 1. Study Module

Problem Construction Module
This module helps teachers provide WRPs for learners to solve. Figure 2 illustrates the processes of making problems briefly.

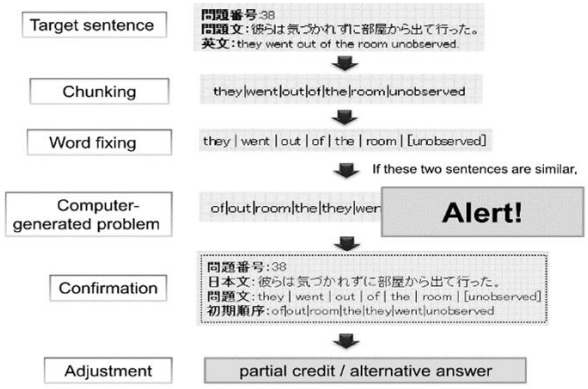


Figure 2. Procedure for a WRP construction

All teachers have to do is just to type correct sentences in English and the corresponding meaning in Japanese. Teachers may use "chunking" and/or "word fixing" functions if they want to make the problem easier or shorter. By using the chunking function, a series of words become one group when the straight-bar(s) "|" that separate each adjacent words are deleted, and the group of words will be treated as one word, making the number of words included in the problem smaller. The word fixing function is also available when teachers prefer to make the problem easier or shorter by literally fixing the

word position in a sentence. Once a word is fixed to a certain position, learners are not able to change it, which means that learners have only to move the rest of the words in the problem.

Furthermore, this function is the most useful when teachers wish to avoid double/multiple correct answers to one problem. The computer's binary recognition system accepts only one generated sentence as the correct answer unless another or other correct ones have been additionally programmed in advance. The "word fixing" function makes it easier to deal with a sentence composed of words that can be arranged into more than one correct order. For example, the sentence, "They went out of the room unobserved" can also be ordered correctly as "Unobserved they went out of the room." Using this function, though, teachers can fix the position of "unobserved" in the initial or end position (as in Figure 2), and thereby prevent the possibility of double correct answers.

After these procedures have been through, teachers can choose one of three break down methods: optional, alphabetical, or randomized order (Figure 3).

Figure 3. Choice of a break down method

Automatic randomization is the easiest to use and will be the most preferred, but there is a slight, yet rather serious danger of producing a WRP which is similar in form to the correct sentence, especially when the number of words to be moved is as small as seven or eight. The similarity to the correct sentence will make the problem much easier for learners to solve, thus fewer movements of the mouse will be necessary in solving it. If automatic randomization produces a similar word order to the target structure, the teacher can repeat using randomization until the word order in the problem is quite different from that of the correct sentence. Another break down method is an alphabetical word order, in which chances for the similarity to happen become smaller. However, alphabetical-order arranging may not be perfect, either, creating a problem that has already formed an important structure used in the sentence. An "Alert" function is incorporated into this module to eliminate a teacher's burden of checking these similarities between the problems' word orders and correct sentences. When notified by "Alert" that the problem created has a similar word order to the answer, namely, the pre-specified ratio of words--or more--are already in order, or a crucial idiom, which might be worth some partial credit, is already in the correct order, teachers will never fail to change the word order in the problem by randomizing again or using a third method, the optional word order, which allows the teacher to choose the order.

In the last stage of making problems, confirming the target sentence (=answer) and the word arrangements in the problem, teachers can prepare partial credit for a correct part of a sentence or a sentence which is not completely correct but good enough to make sense (e.g. Olympics are watched by the people all over the world).

Retrieval & Analysis Module

The study log data recorded by the Study Module when learners perform tasks, can be retrieved and analyzed by using one of the six menus in the Retrieval & Analysis Module. The menus included in this module are Reproduction, Learner Analysis, Problem Analysis, Study Log Retrieval, Correlation Analysis, and Clustering menus, each of which has links to related pages of other menus so that teachers are able to have an access to sets of data they want to check.

1) Reproduction: mouse trajectories are reproduced in visible lines whose color changes in every ten seconds so that the newer lines can be identifiable when the trajectory lines overlap, with reproduction speed changeable from 50 % to 500% of its original speed, and also with reproduction being able to start at any selected point on the slider (Figure 4).

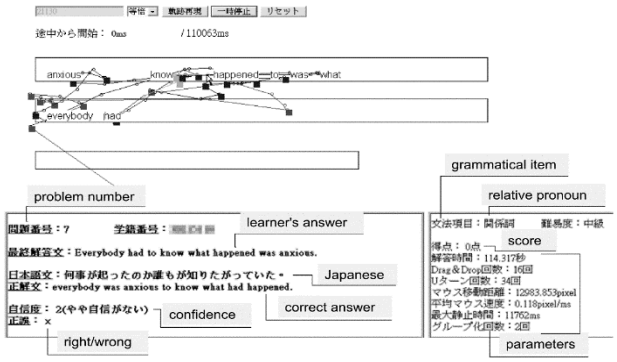


Figure 4. Reproduction of mouse trajectories

2) Learner Analysis: data for a particular learner is available, such as the percentage of correct answers classified by grammatical items, the total number of problems attempted, the total elapsed logon time, the percentage of overall correct answers, as well as the average time needed for answering problems (Figure 5).

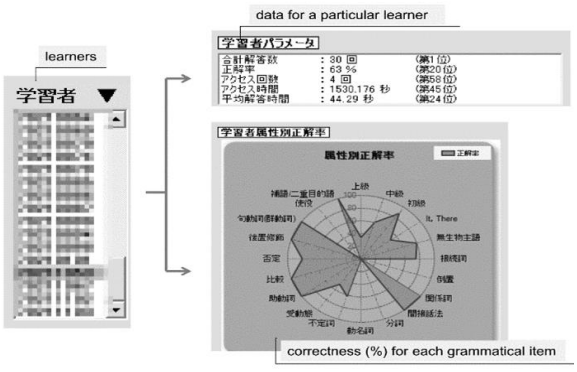


Figure 5. Learner analysis

3) Problem Analysis: data for a particular problem can be reviewed, such as the number of times the problem was attempted, the percentage of correct answers, the average time needed for answering, and so on (Figure 6).

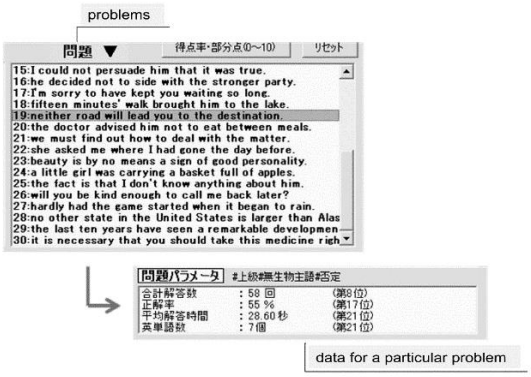


Figure 6. Problem analysis

4) Study Log Retrieval: this menu helps teachers retrieve data for specific criteria they want to focus on. Combining several search types and commands, the teacher can easily have an access to, for example, learners that used U-turns --the right-and-left, or up-and-down mouse movements--more than 15 times to solve a particular problem, learners that have used this software in the last two months, or problems that required D&Ds less than 10 times for a certain learner to solve, and so on.
5) Correlation Analysis: with this menu correlation analysis is available for all combination of parameters showing the elements of the mouse movements--such as response time needed, the number of D&Ds, the total distance of mouse movement, and the number of U-turns--from either the learners or the problems perspective. Figure 7 is an example of correlation between the average time for answering and the average scores, with each dot representing a particular learner. We see a roughly negative correlation here, which means that the less time needed for answering, the higher the scores.

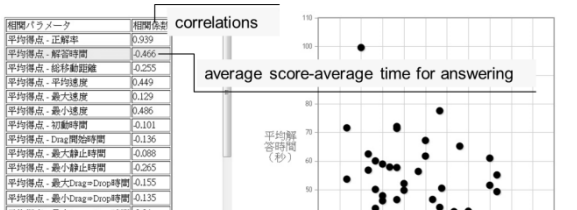


Figure 7. Correlation analysis (the average time for answering/the average scores)

6) Clustering: this function assembles similar learners in groups. In this study, considering the large difference in the variances and scales of each parameter, a standardized Euclidean distance was used instead of the generally used (non-standardized) Euclidean distance. Ward's method was adopted for computing the distances among clusters. Teachers can choose the number of clusters and which parameters to be incorporated for clustering criteria, from "the number of problem attempted per learner," "the ratio of correct answers," "the number of times accessed," "total elapsed logon time," and "average answer time."

The newly incorporated function for the latest experiment to be conducted is a function to retrieve the trajectories of how each word is treated by each D&D. The former system counted the total number of D&Ds, U-turns, and the time needed in solving a whole problem, but the new system enables us to observe each word movement. D&D(s), U-turn(s), and the time used in the treatment of one word, as well as the time elapsed between a particular drop and the click of the next word (D-C time), namely the time between a particular D&D and the next D&D, and standstill time of the mouse can be retrieved now. These data are expected to contribute to reveal more delicate points in the course of performing tasks.

4. EXPERIMENT and DISCUSSION

Asking 40 students with a variety of majors at a certain university in Japan, to solve 30 problems using the e-learning system we have developed, we conducted an experiment in which the subjects were informed that their mouse trajectories would be recorded and analyzed for the purpose of investigating the solving processes. 1,178 sets of data were collected in total, with 22 sets of data being inappropriate for analysis owing to a recoding failure.

Confident and Correct Answers as Norm

The answers the subjects reached in our former experiment fall into one of four categories: 1) confident and correct, 2) confident but not correct, 3) not confident but correct, and 4) not confident and incorrect. Confident answers belonging to categories 1 and 2 include useful mouse movement logs for finding the norm of "answers without hesitation or uncertainty," although the learners who produced category 2 type of answers should review and learn the correct sentence. The answers from category 3 need very careful treatment because most computer marking systems may evaluate them as "passing" in spite of the fact that learners are not yet sure of the correct answer, or they might have reached the correct answers accidentally. There is no need of analyzing the answers of category 4 for the purpose of ascertaining learners' understanding levels because they clearly do not understand, which means that they have to review from the beginning, but these answers also offer very useful data for uncertainty or lack of confidence in terms of mouse trajectories.

The answers that fell into category 1 totaled 207 in the latest experiment, which we use as the norms, and compare the norms with mouse trajectories included in 171 answers of category 4 (in which learners are not certain or confident), in order to investigate whether or not there are any significant differences between them. Since confident and correct answers will show smooth mouse movements with the least hesitation, these differences will lead to the clues for detecting unnecessary and uncertain movements caused by hesitation owing to lack of confidence or knowledge.

Comparison between Category 1 (Confident and Correct) and 4 (Not confident and Incorrect)

Focusing on several parameters for mouse movements, we compare the distributions of the answers in two categories. The following graph is a comparison of time needed for answering each problem (Figure 8).

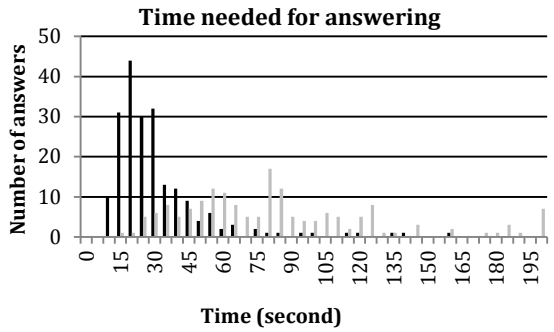


Figure 8. Distribution of time needed in the two types of answers: black-category 1, and gray-category 4

The difference is clearly seen in the graph, but in order to numerically illustrate the degree of difference between the two types of answers, we calculate the deviation: when the norm is determined on the basis of category 1, deviation calculated in terms of the average for the answers in category 4 shows 97.36, with 84.2% of answers of category 1 being higher than 65 in deviation value.

Another comparison is of the longest D-C time during performing tasks, as is seen in Figure 9 below.

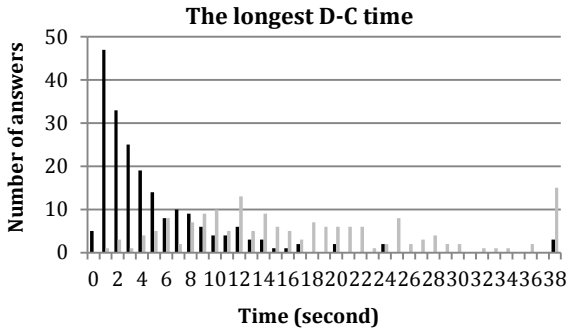


Figure 9. Distribution of the longest D-C time in the two types of answers: black-category 1, and gray-category 4

The deviation value here is 81.73, with 75.44% of answers showing higher values than 65.

Calculating deviations by comparing the average values from the answers of one group (category 4) with the norms determined on those of another group (category 1), in a strict statistical sense, might not be the most appropriate way, but it will suffice to demonstrate that two groups are totally different or almost the same.

Other comparisons (average velocity of mouse movement, the longest standstill time, and the number of U-turns) also reveal pretty large differences between the two types of answers, while time elapsed from completion of reordering to pushing OK button (which is expected to be the time for confirmation) indicates no significant difference between the two groups (Table 1).

Table 1. Deviation of parameters in category 4 (not confident and incorrect answers) from the norm

	P1	P2	P3	P4
Deviation	35.91	72.95	V:73.59 H:69.40	49.65

P1: Average velocity of mouse speed
P2: The longest standstill time
P3: The number of vertical (V) and horizontal (H) U-turns
P4: Time elapsed from completion of reordering to pushing OK button

Distribution of Category 3 (Not Confident but Correct) Type of Answers

The parameters showing large differences from the norms, and indicating lack of confidence or knowledge required in solving the problem, can be included even in correct answers, as many cases found in 72 answers of category 3 (not confident but correct). Time for answering in category 3 (correct answers) and 4 (incorrect answers) in Figure 10 does not illustrate a large difference between the two as clearly seen in Figure 8, which also compares the time for answering in correct answers and incorrect answers.

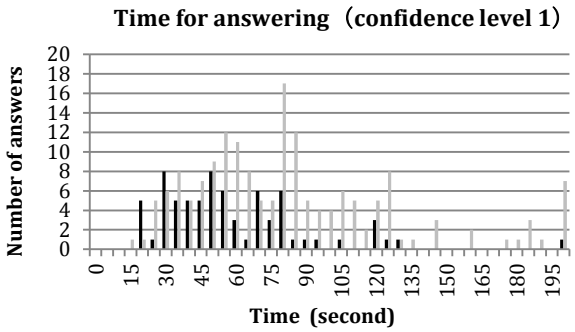


Figure 10. Distribution of time needed in the two types of answers: black-category 3, and gray-category 4

Similarly, the longest D-C time in category 3 and 4 shows little difference as in Figure 11.

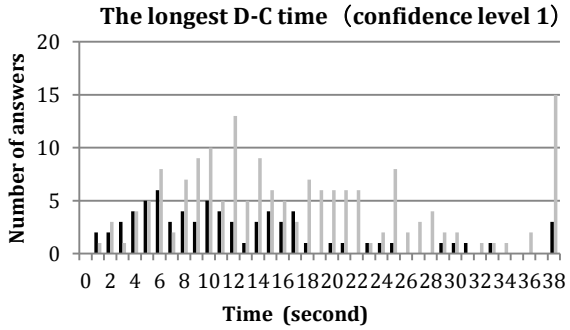


Figure 11. Distribution of the longest D-C time in the two types of answers: black-category 3, and gray-category 4

Although the answers belonging to category 3 are correct and those of 4 are incorrect, the mouse trajectories of the answers

both in categories 3 and 4 are nevertheless similar in terms of the parameters for time needed for answering and D-C time. The learners whose answers include these trajectories with parameters evaluated as "not confident," need to review the same type of problems because they have not yet reached an adequate understanding of the target grammatical items, such as sentence structure, collocations, usages, or idioms irrespective of the correctness of their answers.

5. CONCLUDING REMARKS

The results of our experiment and analyses reasonably suggest that the parameters showing large differences from the norms, (especially time needed for answering, D-C time, average velocity, standstill time, and the number of U-turns), can be used as clues deeply connected to lack of confidence and hesitation of mouse movements, and these parameters will be applicable to identify hesitative part(s) in individual learners' solving process of each problem when a proper mathematical treatment is given to mouse trajectories produced by individual learners.

Though insufficient in number to illustrate the distribution or to calculate correlation coefficients with confidence levels, the adjusted number of D&Ds (the number of words included in the problem is reduced from the total number of D&Ds in order only to calculate the pure number of D&Ds that exceeded the minimum number necessary), the D&Ds of the same word, and the number of D&Ds in the answer slot (replacements of words in the answer slot) are also assumed to be indicative of hesitation in the process of performing tasks since they are excessive mouse movements. They are very likely to be useful as clues to locate where in the process of solving one problem hesitation occurs.

In order to verify that these D&Ds clearly feature difficulties the learners are experiencing and in order to ascertain accurately when and where hesitations occur in their positioning of the words in the target sentence, our future tasks should include:

1) finding appropriate ways to treat the D&Ds' data mathematically for the purpose of connecting them to learners' understanding levels,
2) calculating personal norms of each learner to measure the difference of the important parameters showing hesitation,
3) incorporating the automatic retrieval function of the important parameters in the process of solving one problem to determine where in each reordering the hesitation occurs, so that they will be displayed on the screen of learner analysis menu, and
4) combining the parameters in some pattern to examine how they are useful for more accurate identification of hesitation.

To collect adequate data for important parameters which will contribute to personal analyses, we need to conduct experiments in which learners are required to solve more than 30 problems as well as to continue improving the system.

ACKNOWLEDGMENT

This work was supported by a Grant-in-Aid (KAKENHI) for "Scientific Research (C) (25370621)."

REFERENCES

[1] C. Tateda, et al., "Evaluation of an Individual Authentication System Using the Trajectory by the Mouse", **IEICE Technical Report, HCS** 105(74), 2005, pp. 17-20.
[2] Y. Ohmori, et al., "Understanding Learning Effect Using MBC (1)-Analysis of Mouse Behavior", **Conference on IT Education**, 2006, pp. 51-54.
[3] E. Arroyo, et al., "Usability Tool for Analysis of Web Designs Using Mouse Tracks", **Proceedings of CHI EA'06, ACM**, 2006, pp. 484-489.
[4] M. Ikegami, "Enhancing Students' English Reading and Listening Skills through the Use of the Computer-assisted Intensive English Training Program", **Journal of Language and Literature**, Vol. 26, No. 1, 2006, pp. 103-26.
[5] M. Ikegami, "Enhancing Student's English Reading and Listening Skills through the Use of the Computer-assisted Intensive English Training Program III--The Effect of Learning Environment and Course Design--", **Journal of Language and Literature**, Vol. 29, No. 1, 2009, pp. 229-257.
[6] J. B. Freeman, and N. Ambady, "MouseTracker: Software for studying real-time mental processing using a computer mouse-tracking method", **Behavior Research Methods**, Vol. 42, No. 1, pp. 2010, 226-241.
[7] K. Nakamura, et al., "Estimating Learners' Subjective Impressions of the Difficulty of Course Materials by Observing Their Faces in E-Learning", **Journal of the Institute of Electronics, Information and Communication Engineers**, Vol. J93-D, No.5, 2010, pp. 568-578.
[8] Y. Horiguchi, et al., "An Automatic Estimation System of Learners' Impasses Based on Features in Low-Level Interactions in an E-Learning Environment", **The 24th Annual Conference of the Japanese Society for Artificial Intelligence**, 2010, 2F1-3.
[9] Y. Miyazaki, et al., "Web Application for Recording Learners' Mouse Trajectories and Retrieving Their Study Logs for Data Analysis", in eds. J. Cheng, G. Fu, and X. Han, **Technology Enhanced Language Learning**, 2011, pp. 95-99.
[10] M. Zushi, et al., "Web Application for Recording Learners' Mouse Trajectories and Retrieving their Study Logs for Data Analysis", **APTEL 2011 Best papers: Knowledge Management & E-Learning: An International Journal**, Vol. 4, No. 1, 2012, pp. 37-50.

A Model for Customer Lifetime Value Focusing on the Manufacturing Supplier Industry

Tatsuya Mori
Faculty of Industrial Administration,
Tokyo University of Science,
2641 Yamazaki, Noda,Chiba, 278-8510, Japan
j7412629@ed.tus.ac.jp

Katsutoshi Kanamori
Faculty of Industrial Administration,
Tokyo University of Science,
2641 Yamazaki, Noda,Chiba, 278-8510, Japan
Katsu@rs.tus.ac.jp

Hayato Ohwada
Faculty of Industrial Administration,
Tokyo University of Science,
2641 Yamazaki, Noda,Chiba, 278-8510, Japan
ohwada@rs.tus.ac.jp

ABSTRACT

Customer Relationship Management (CRM) assumes that firms can become more profitable if they can invest in superior customer. Many studies have been performed to calculate customer value based on the Customer Lifetime Value (CLV). In this paper, we propose a customer value calculation model that focuses on the industry of build-to-order manufacturing using data mining techniques and time series analyses. The proposed model combines data mining and time series analysis. First, it classifies the customers into three groups (superior, middle, inferior) by using data mining methods. Second, it predicts customer value using a time series analysis for each group of customers. We evaluate the proposed model to estimate the future value of customers using sales data for a firm in the manufacturing industry. The result shows that the model can identify superior customers in the long term.

Keywords: CLV, RFM, CRM, Data Mining, Manufacturing Industry

1. INTRODUCTION

For allocating resources, it is important to estimate the Customer Lifetime Value (CLV) correctly, especially for business to business firms. When businesses estimate the CLV, it becomes possible to create a marketing strategy for supporting efficient activity, and increasing the budget for new business development. The CLV represents the present value of the expected benefits (gross margin) minus the burdens (direct costs of servicing and communicating) imposed by customers [1]. CLV has become a general indicator in customer relationship management [2] and in customer equity approaches to marketing [3,4].

In some Asian countries, most manufacturing industries supply a product to one specific major company. As cost cutting become important for the major company, it is common for them to request lower-priced products from the manufacture supplier. A problem arises because the major companies have more power, so the supplier will tend to lower their prices. This leads to increased competitiveness among supplier to manufacturing industries. Supplier often lack of the ability to acquire a new customers. Only a few suppliers are able to acquire new customers by minimizing the number of non-profitable customers. Therefore, most suppliers need to calculate the customer value in order to gain more profit.

This paper proposes a customer value calculation model that focuses on the industry of build-to-order manufacturing using data mining techniques and time series analyses. The distinguishing feature of the proposed model is the point of taking into consideration each customer's characteristics in the manufacturing industry, and applying a different calculation technique for every characteristic of the customer group. In the experiment, we estimate customer value of five years into the future. The proposed model indicates that it is better to identify the superior customers. We consider that identifying superior customers leads to optimize operating costs, and brings in new customer.

2. RELATED WORK

Many studies have discussed the evaluation of CLV. Hughes [5] proposed a method for RFM scoring by using RFM data that involved sorting individuals into five customer groups. Different marketing strategies could then be adopted for different customers. Goodman [6] suggested that the RFM method should avoid focusing on less profitable customers, allowing resources to be diverted to more profitable customers. Stone [7] suggested that different weights should be assigned to RFM variables depending on the characteristics of the industry. In analyzing the value of customers who used credit cards, he suggested placing the highest weighting on the Frequency measure, followed by Recency, with the lowest weighting on the Monetary measure.

Edward and Malthouse [8] predicted CLV for a B2B company. In the research, authors used a linear regression estimated with

iteratively re-weighted least squares (IRLS), as described in Neter et al. [9] and estimated IRLS for the business-to-business company. They evaluated its predictive accuracy by a classification test. A partial goal of CLV is to separate the "best" customers from others. For simplicity, they assumed that the top 20% based on actual CLV values in the target period were the "best" customers.

3. CHARACTERISTICS OF THE MANUFACTURING INDUSTRY

Compared to a B2C business model, a B2B business model such as for a manufacturing industry has fewer customers, and the product's unit price and the customers' repeat rate are high. However, since the purchase is judged rationally and objectively, it also features a long time before the merchandise purchase. Therefore, when a company gets into a confidential relation with a customer, the possibility of the customer continuously purchasing a product which he had previously purchased is high. A customers who left in spite performed buy, potentially without going satisfied customer care or products and moved to other companies is high??. In this study, we assume that customers with a strong, confident relationship with the supplier will perform long-term and periodic purchases, whereas customers with a low-confidence relationship will move to other companies.

4. LITERATURE REVIEW

4.1. RFM

RFM analysis is a marketing technique used for analyzing customer behavior such as how recently a customer has purchased, how often the customer purchases, and how much the customer spends. It is a useful method for improving customer segmentation by dividing customers into various groups for future personalization services and to identify customers who are more likely to respond to promotions.

Bult and Wansbeek [10] defined RFM as follows.
(1) R (Recency): The period since the last purchase; a lower value corresponds to a higher probability of the customer making a repeat purchase.
(2) F (Frequency): Number of purchases made within a certain period; higher frequency indicates greater loyalty.
(3) M (Monetary): The money spent during a certain period; a higher value indicates that the company should focus more on that customer.
We provide below an example of how to interpret the RFM analysis result. A customer with a high R score is more likely to use that product in the future. However, there is a high probability that a customer with a low R score was taken by another company. A high F score implies a frequent customer. Although a customer with a high F score and a low R score was frequent customer once, he is considered to now have been taken by another company. A customer with a high M score indicates purchasing power. RFM is generally estimated using five ranks, and each customer's characteristics are represented with their own combination.

4.2. THE HOLT-WINTERS FORECASTING PROCEDURE

Exponential smoothing methods [11,12] are popular, easy to use, and generally work well. The Holt-Winters method generalizes this approach to deal with trends and seasonality. The multiplicative seasonality version of the method is presented in expressions (1) to (4). It assumes an additive trend and estimates the local slope, T_t, by smoothing successive differences, $(S_t - S_{t-1})$, of the local level, S_t. The local s-period seasonal index, I_t, is estimated by smoothing the ratio of the observed value, X_t, to the local level, S_t.

$$S_t = \alpha\left({X_t}/{I_{t-s}}\right) + (1-\alpha)(S_{t-1} + T_{t-1}) \quad (1)$$

$$T_t = \gamma\left({S_t}/{S_{t-1}}\right) + (1-\gamma)T_{t-1} \quad (2)$$

$$I_t = \delta\left({X_t}/{S_t}\right) + (1-\delta)I_{t-s} \quad (3)$$

$$\widehat{X_t}(k) = (S_t - kT_t)I_{t-s+k} \quad (4)$$

Here, $\propto$, γ and δ are smoothing parameters, and $\widehat{X_t}(k)$ is the k-step-ahead forecast. The seasonality is multiplicative in the sense that the underlying level of the series is multiplied by the seasonal index.

4.3. K-MEANS CLUSTERING

K-means is one of the simplest unsupervised learning algorithms that solves the well known clustering problem. The procedure follows a simple and easy way to classify a given data set in to a certain number of clusters (assume k clusters) fixed a priori. The main idea is to define k centroids, one for each cluster. These centroids should be placed with care, because different locations will lead to different results. The best choice is to place them as far away from each other as possible. The next step is to take each point belonging to a given data set and associate it with the nearest centroid. When no point is pending, the first step is completed and early grouping is considered to be complete. At this point, we need to re-calculate k new centroids as barycenters of the clusters resulting from the previous step. After we have these k new centroids, a new binding has to be done between the same data set points and the nearest new centroid. A loop has been generated. As a result of this loop, we may notice that the k centroids change their locations step by step until no more changes are made, in other
words until the centroids do not move any more. Finally, this algorithm aims at minimizing an objective function, in this case a squared-error function.

5. PROPOSED MODEL

This section first defines the customer value in this research. Next, the flow of the whole proposal model is presented. We define CLV as the sum of the revenues gained from a given customer over the lifetime of transactions. Therefore, in this study, we attempt to predict the value correctly by focusing on the profits obtained from a future customer.
In the proposed model, each customer's future value is predicted using sales data. First, we classify the customer using RFM analysis because the sales data has characteristics that change with a customer's group. A customer who is purchasing frequently and continuously indicates a certain amount of regularity. Moreover, a customer who is not purchasing frequently and continuously has a high possibility of being taken by other companies. The flow of the proposed model is diagrammed in Fig. 1.

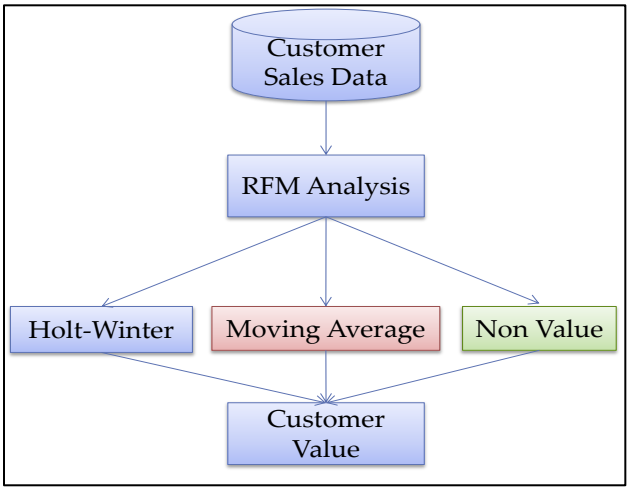


Fig. 1. The flow of a proposal model

5.1. CUSTOMER CLASSIFICATION BY RFM ANALYSIS

First, we analyze each customer's purchase tendencies using an RFM analysis. The numerical value of the computed RFM is classified into five ranks according to the k-means method. (The best value is rank 5, the worst value is rank 1.) An example of RFM analysis is given in Table 1.

Second, the customers were classified into three groups based on the RFM clusters.

1. Superior customer group
This group consists of the customers for whom both RF scores exceed 4. A customer in this group is a customer who has traded continuously right up to the present. The company needs to demonstrate continuous interest in dealing with such a customer.

2. Inferior customer group
This group consists of customers for whom both RF scores are less than 2. A customer in this group will seldom generate future income. It may become a waste of operating cost to pursue business with such a customer.

3. Medium customer group:
This group consists of customers who are not included in the above classifications. Customers in this group do not have significant distinguishing features. However, the customers in this group include customers whose R score alone is high. The company needs to build a stronger relationship while continuing to trade with such a customer.

5.2. CALCULATING THE CUSTOMER VALUE

As stated above, we assumed that there is a tendency in the sales data for every characteristic of the customer. We present two hypotheses. The first is that the sales data of the superior customer group has a periodic law (i.e., seasonality). The second is that the inferior customer group has moved to another company. Therefore, we apply a predictive method to each group.

Table 1 Example of RFM analysis

id	R (Actual value)	F (Actual value)	M (Actual value)	R	F	M
1	612	1	75600	3	1	1
2	299	37	4274760	4	1	1
3	2538	1	50400	1	1	1
4	5	144	13568520	5	2	2
5	54	62	2229675	5	1	1

1. Superior customer group
We apply the Holt-Winters method to this group because we think these customers have higher F and R and have been trading long-term in the past. Seasonality is included in the sales data.

2. Inferior customer group
We assume that the customers in this group do not have value. Therefore, we define the customer value of this group as 0.

3. Medium customer group
We apply the moving average method to this group. A moving average is one method of representing stationary process sequences and is often used to predict the future. When new data is obtained over time, the average method combines the new data with the data of a former certain fixed period and updates those central values one by one. The easiest technique involves taking the arithmetical average of a certain fixed period using the same weight; this is called a simple moving average (SMA). We predict the demand over the next year based on the purchase amount for a unit year in the past. The customer value is denoted by the following formulas.

$$Y_t = \frac{\sum_{k=-N}^{N} Y_{t-N}}{N} \quad (5)$$

where N is the period to predict, and Y_t is the predicted value for the next year.

6. EXPERIMENT

In the experiment, we used sales data for the manufacturing industry, which sells industrial products, such as molds. For each of these customers, we have the transaction history over a seven-year period. The transaction file gives the customer ID, date, commodity ID, and price for each transaction. We applied the proposed model using the customers of 104 companies represented in this data.

6.1. EVALUATION

For this evaluation, we use the first two years as the base period and the last five years as the target period. We evaluate its predictive accuracy in two ways.
The first way is the Spearman's rank correlation coefficient. This clarifies the similarity between two rankings. We compare the customer ranking based on the actual value and the customer ranking based on the predicted value. Spearman's rank correlation coefficient is given by the following formula.

$$r_s = 1 - 6 * \frac{\sum_{i=1}^{n}(x_i - y_i)^2}{n(n^2-1)} \quad (6)$$

Table 2 Allocation of TP, TN, FP, FN

		Actual	
		1	0
Predict	1	TP	FP
	0	FN	TN

Here, x_i,y_i are converted to ranks, and n is the size of the raw data. The value of r_s ranges from -1 to 1. It was determined that there is more correlation in the ranking of the two for values closer to 1.

The second approach is classification authorization, which Edward and Malthouse performed. We assumed that the top 20% based on actual CLV values in the target period are the "best" customers. Classification authorization was used to evaluate whether the proposed model predicted the actual top 20%. It is calculated using the following indices.

$$\text{accurary} = \frac{TP + TN}{TP + TN + FP + FN} \quad (7)$$

$$\text{recall} = \frac{TP}{TP + FN} \quad (8)$$

$$\text{precision} = \frac{TP}{TP + FP} \quad (9)$$

$$\text{F} - \text{score} = \frac{2 * recall * precision}{recall + precision} \quad (10)$$

TP, TN, FP, and FN in the formula represent True Positive, True Negative, False Positive, and False Negative. These are used to represent the distribution of the classification (Table 2).

6.2. RESULTS

After classifying 104 companies according to RFM, we found 23 customers in the superior customer group, 89 in the middle customer group, and 29 in the inferior customer group.
We present the results of the two evaluations below. Measures of Spearman's rank correlation coefficient are listed in Table 3. The r_s value is low as the period of prediction increases. Next, measures of classification authorization are summarized in Table 4. According to Table 4, accuracy is high through the whole period. However, recall, precision, and F-score for two and four years are somewhat low. Finally, the prediction error is given Table 5. The prediction error becomes high as the period of prediction increases.

6.3. DISCUSSION

Over five years, the r_s value remains high. In particular, the one-year value is very high. The proposed model is thus suitable for predicting customer ranking. Next, classification authorization again generally takes on a high value . However, the values for two and four years are somewhat low. The overall sales for these years are very low compared with the previous year, so an external factor may be involved. Finally, it is difficult to evaluate the prediction error. However, the amount of money for one typical customer's annual average purchases is about 4 million yen. Considering this, we think that the error for the first year is low. However, the errors for other years are quite high.

Table 3 Measures of Spearman's rank correlation coefficient

Future(t)	1year	2 years	3 years	4 years	5 years
rs	0.930	0.868	0.839	0.831	0.806

Table 4 Measures of classification authorization

	accuracy	recall	precision	F-score
1 year	0.90	0.75	0.75	0.75
2 years	0.87	0.65	0.65	0.65
3 years	0.88	0.70	0.70	0.70
4 years	0.84	0.60	0.60	0.60
5 years	0.90	0.75	0.75	0.75

Table 5 Prediction error

Future(t)	error (yen)
1 year	11,066,420
2 years	517,559,860
3 years	675,094,387
4 years	1,551,678,601
5 years	3,584,517,449

We believe the proposed model predicts well for one year into the future, and that it is suitable for classifying superior customers over a given period. The size of the prediction error seldom affected the classification accuracy.
A company can thus distinguish superior customers with high accuracy and can perform its operating activities efficiently by using this model in real situations.

7. CONCLUSIONS

In this paper, we proposed a customer-value calculation model that focuses on the industry of build-to-order manufacturing. In an experiment, we predicted customer value five years in the future. The proposed model indicates that it is best to distinguishing high-value customers. We believe the company can perform business activities efficiently by using the proposed model and can make a budget for new business development.

8. REFERENCES

[1] Robert Dwyer, F, "Customer Lifetime Valuation to Support Marketing Decision Making" **Journal of Direct Marketing**, 11(4), 6–13. 1997.

[2] Sheth, Jagdish N., Banwari Mittal, and B. Newman. "Customer Behavior: Consumer Behavior and Beyond Fort Worth" **The Dryden Press**. 1999.

[3] Blattberg, Robert.C., Getz, G. , & Thomas, J.S. "Customer Equity: Building and Managing Relationships As Valuable Assets. Boston" **Harvard Business School Press.** 2001.

[4] Rust, Roland T., Zeithaml, Valarie A., & Lemon, K.N. "Driving Customer Equity: How Customer Lifetime Value Is Reshaping Corporate Strategy" New York: **The Free Press.** 2000.

[5] Jackson, Robert R., Paul Wang, and Lisa Petrison, "Strategic Database Marketing", Probus Publishing **The Masterplan for Starting and Managing a Profitable, Customer Based Marketing Program.** Chicago, 1994.

[6] Goodman, John, "Leveraging the customer database to your competitive advantage", **Direct Marketing**, Vol 55, pp. 26-27, 1992.

[7] Bob,Stone, "Successful Direct Marketing Methods, Lincolnwood", **NTC Business Books**, IL, 1995.

[8] Malthouse, Edward C,& Robert, C. Blattberg. "Can we predict customer lifetime value" . **Journal of Interactive Marketing.** 19(1) 2–16. 2005.

[9] Neter, J. & Wassetman, W. "Applied Linear Statistical Models". Homewood, IL: Irwin.1985.

[10] Liu, Duen-Ren, and Ya-Yueh Shih, "Integrating AHP and data mining for product recommendation based on customer lifetime value", **Information & Management,** Vol 42, pp. 387-400, 2005.

[11] Gardner, E.S., Jr..,"Exponential smoothing: The state of the art", **Journal of Forecasting**, 4, l-28. 1985.

[12] Newbold, P., "Predictors projecting linear trend plus seasonal dummies", **The Statistician**, 37, 111-127. 1988.

[13] MacQueen, James.: "Some Methods for classification and Analysis of Multivariate Observations", **Proceedings of 5-th Berkeley Symposium on Mathematical Statistics and Probability**, Berkeley, University of California Press, 1:281-297 1967.

The Feasibility Study for Establishment of Passenger Rail in the Metropolitan Region of Belo Horizonte / Brazil

Marcelo Franco PORTO
School of Engineering, Federal University of Minas Gerais
Belo Horizonte, Minas Gerais, Brazil

and
Luiz Carlos de Jesus MIRANDA
Nilson Tadeu Ramos NUNES
Cássio E. dos SANTOS Jr.
School of Engineering, Federal University of Minas Gerais
Belo Horizonte, Minas Gerais, Brazil

ABSTRACT

The rail transportation, either of passengers or cargo, is essential to the country's economic growth. Due to a number of factors, in particular, severe mobility problems experienced by large cities and a demand for urban transport systems and suburban high capacity transport on rails going through a period of recovery with new investments being announced both for the construction of new railway sections, as for reclamation and re-adaptation of existing railway networks. In this context, the liability of decades without investment, necessitates a rational use of available resources and agile enabling to country develop projects for the sector rapidly and consistently. This paper presents a proposal that aims to make it easier to review and registration of a railroad. The proposal is obtain a film at 360 ° with a spherical vision camera Lady Bug (6 cameras) from Point Grey Research, a Sony Full HD Camcorder and a Sony High Resolution camera with integrated GPS system. The images collected will be stored in a georeferenced database in a computer system developed for this purpose which will be able to contain the record of all events by the slice, generating reports with data, pictures and location map. Applied to the specific case of metropolitan region of Belo Horizonte/Brazil. The data obtained in the study of railway network BHMR and surroundings, were used to subsidize the State Government, through the Agency for Development of the Metropolitan Region of Belo Horizonte, in assessing the feasibility of implementing transport passenger rail in this network.

Keywords: Infrastructure Engineering, Engineering Management, Spatial Analysis, Digital Image Processing.

1. INTRODUCTION

Rail transport in Brazil is experiencing a resurgence after decades with little or no investment, mainly in the construction of new roads. Due to economic growth in recent years, there has been an increase in government investment and private sectors of the rail industry, both in cargo as passenger. Only the federal government nods investments of $ 45 billion over the next 25 years when it intends to build about ten thousand kilometers of new railways (Ministry of Transport) [1], which corresponds to more than one-third the length the current mesh. In addition to these investments, can be considered promising the creation of the EPL - Logistics Planning Company S/A, a company of the federal government in charge of strategic planning in the area of transport infrastructure.

There are investments to existing lines disabled or in poor condition, as well as incentives for redeployment of passenger transport in sections where only the cargo remained. These lines could play a strategic role in the mobility issue because they are in metropolitan regions or make the connection between cities large and medium-sized with a large demand for high capacity transportation.

2. HISTORICAL DEVELOPMENT

The railroads arrived in Brazil still in the Imperial period. A special law of 1852, which established the security interest on the capital invested in railway construction, besides other advantages is it possible to leverage the construction of the first railroads in Brazil. The first section, 14.5 km in length and gauge of 1.68 m, was inaugurated by D. Pedro II on April 30, 1854 [3].

The railways were developed at a good pace, in 1888 the country had 9200 km of railways built 9000 km and more under construction or study. Between the years 1905 and 1915 were built more than ten thousand kilometers of railways [3]. In 1922, the Brazilian railway has reached 29,000 km in length, dimensions very similar to today .

The initial policy of building railways left, however, negative marks felt until today. A wide variety of gauges is a hindrance to the operational integration between railroads today. Tracings extremely sinuous added to this huge variety of gauges (gauges 70cm to 1.68m with the largest) are harmful to operating speed and load capacity [4], in addition, requires the achievement of transhipment, both freight and passenger in the connection between extensions of different gauges. Another important negative mark is the fact that they created regional networks scattered and isolated preventing the integration of Brazil by rail [3]. After the peak, lived until 1920, the railways in Brazil began to decline with fewer investments, being passed over during the 50s and 60s in favor of highways, culminating in the extinction of RFFSA - Federal Railway S/A in 1999 after privatization of its lines .

Figure 1 shows the map of the current Brazilian railway, showing the existing railway lines to their utility beyond the lines currently under construction or planned your deployment.

After privatization, the passenger was abandoned and the investments made only in the way in which the transport of cargo were profitable, leaving the remaining stretches of high economic and historical importance to the communities they served, as in the case of railway connecting Belo Horizonte to Ouro Preto [2] which is not operational, and much of its length, there is no longer the track superstructure.

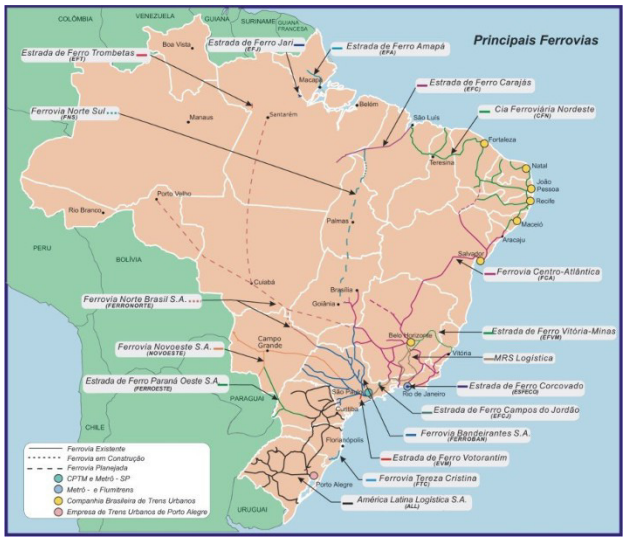


Figure 1.

Malha Ferroviária Brasileira.

Source: Ministério dos Transportes. [1]

After this long period without massive investments in the public sector, the current situation indicates some changes in the line of government investment, a recovery and a new phase of expansion of railroads in the country. Adding public and private investment, the government program called CAP - Railways (Growth Acceleration Program) provides for the recovery of the existing network and the construction of ten thousand kilometers of new railways in a period of 25 years, according to the Ministry of Transport. Among the PAC Railways are building the New Transnordestina linking the interior to the ports of the Northeast PECEM (EC) and SUAPE (PE), the Railway East-West Integration (FIOL) linking the North-South Railway to the port Ilheus-BA, the expansion of own North-South Railway, the Railway Integration Midwest - FICO and other, as shown in Figure 1. The program also provides for the deployment in the country 's High Speed Train – TAV on Portuguese. There are also investments within the Ministry of Cities related to PAC Urban Mobility in cities that include rail transport with Metro , LRT or Monorail.

3. PUBLIC TRANSPORT IN THE METROPOLITAN REGION OF BH

The Metropolitan Region of Belo Horizonte - BHMR was created in 1973 by the military regime with 14 municipalities. After the 1988 Constitution, has undergone several additions have not obeyed a criterion urban or economic well defined that justified [5]. Today, with 34 municipalities and a total population of 5,414,701 inhabitants according to the 2010 IBGE Census [6], the Metropolitan Region of Belo Horizonte - BHMR is the third largest country in both population and economic development. Almost half the population is in Belo Horizonte, with 2,375,151 inhabitants, the other most populous municipalities are Betim (378,089 inhab.), Contagem (603,442 inhab.), Ribeirão das Neves (296,317 inhab.) showing the historical trend occupancy in MRBH leaving the more central region of the capital toward their peripheries and neighboring counties (Figure 2).

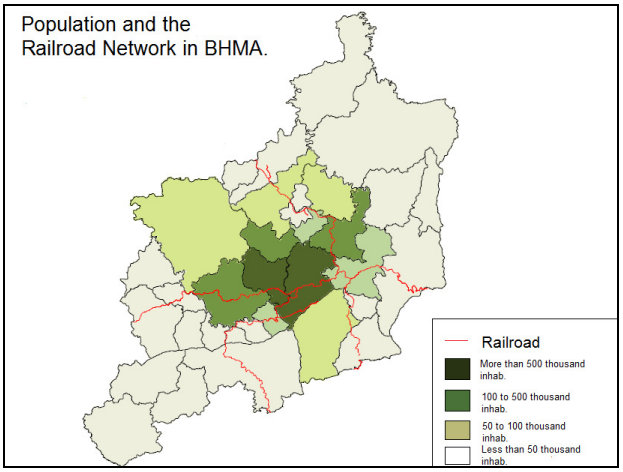


Figure 2.

BHMR Railway Network Traveled.

Source: Prepared by author

M

The BHMR faces severe mobility problems, especially in the capital and neighboring towns, where there was intense process of conurbation. These problems are the result of the lack of appropriate transport policies for decades, the lack of urban planning at metropolitan level, or even at the municipal level for most of the municipalities. Coexists with a low efficiency of public transport where the transport is done almost exclusively in bus mode. The subway BH (a metropolitan train surface) going on for decades in just one line of only 28 km. There are still road corridors, whose capacity is already exhausted, strangled with numerous urban bottlenecks.

These problems, coupled with the intense economic growth and improving the population's income in recent decades, has dumped a number increasing of vehicles on the city streets of BHMR, creating more delays and congestion, fueling the phenomenon known as positive feedback [7] where the increase in the number of cars reduces the efficiency of transportation causing it to lose users who migrate to the private car which in turn will create more slowly and jams. While the population of Belo Horizonte has grown at a rate of 0.94% per annum, the vehicle fleet has grown at a rate of 5.22% [8] so that, according to the 2010 Census, Belo Horizonte has one motorization rate in 2010 of 564 vehicles per thousand inhabitants.

Another difficulty is the absence of a metropolitan traffic management and transport. The three largest cities, Belo Horizonte, Betim and Contagem have municipal companies which are responsible for the administration, and the State only the management of the lines intercity passenger and state highways. The existing municipal bus transportation are not integrated with each other or the metropolitan lines. According to studies by IPTRANS urban mobility published by the city of Belo Horizonte [5], the population of MRBH depends largely modes of transport on foot and by bus beating together, 70% of the displacement of people earning less than three minimum wages.

To build a future scenario in which transportation ensures mobility and accessibility across MRBH, there is an urgent need for a metropolitan planning and multimodal transport. The goal should be to ensure sustainable urban mobility translated as a set of transport policy and traffic prioritizing non-motorized modes and collective transport, effectively, that does not generate spatial segregation, which is socially inclusive and environmentally sustainable (Ministry of Cities) [8].

The PDDI - Integrated Development Plan prepared by the State Government together with civil society points out the guidelines for transportation in the metropolitan region (re) placing the passenger rail as a strategic condition for solving problems and improving mobility accessibility to the entire population :

> *" (...) The conditions of access will only be extended with the dynamics of territorial integration and strengthening of the structure metropolitan network . In this context, it is recognized increasingly, the urgency of a rail system that (re) structured the whole system of passenger transport, currently restricted to cargo transportation. The railways should also enhance integration with other hub cities of Minas Gerais and the country." (PDDI 2011, page 282) [9]*

4. THE TRAIN PROJECT DEVELOPMENT AGENCY BHMR

Project TRAIN (Rail Transport in the Metropolitan Region of Belo Horizonte) developed by the State Government through the Department of Metropolitan Management/Development Agency of the Metropolitan Region of Belo Horizonte, is due to a larger planning of the Government - the Integrated Development plan (PDDI) [9] of BHMR, presented in 2011. This plan is to take advantage of the railway lines to transport passengers and directly serve about 30 municipalities of BHMR and surroundings, a total length of 505 km.

To verify the feasibility, the Agency entered into an agreement with the UFMG - Universidade Federal de Minas Gerais, through the Department of Transport Engineering and Geotechnics, which would be in charge of the University a complete survey of the operating conditions of the entire rail network a radius of 150 km from the center of Belo Horizonte. The study conducted by team NUCLETRANS from the ETG/UFMG, aimed at general, characterize the current situation and analyze the use of the rail network to transport BHMR and around metropolitan and regional passenger to create a network of metropolitan rail transport more integrated and comprehensive.

The project also had the following specific objectives :

Mapping in GIS format of the railway system in the BHMR and the area directly affected by the project;

Evaluation of the physical and operational infrastructure and superstructure existing rail;

Identification and assessment of rail beds that have potential for passenger rail, including sections that are not used for cargo transportation;

Characterization of tracks domain and its immediate surroundings (identifying problems of invasion and/or obstruction of track);

Identification of the current conditions of the main crossings in the municipalities directly affected by the railway line , with assessment of the comfort and safety of traffic affected.

To better organize the collected data and facilitate its analysis, the network is divided into three lots:

The Lot 1 is characterized by the loop that connects the towns of Sete Lagoas Divinópolis (currently operating to the entrance of Sete Lagoas). It is important to note that the urban stretch of Sete Lagoas, after the construction of a bypass that skirts the city, was deactivated and turned into the avenue. This lot is under concession to FCA.

The Lot 2 comprises the loop that connects the city of Barreiro Alberto Flores to the neighborhood in Belo Horizonte (operating), including the extension of Aguas Claras in Nova Lima (excerpt nonoperating) . Most of this batch is under MRS concession.

The Lot 3 comprises the loop that connects the municipalities of Hafizabad Joaquim Murtinho (operational) and Joaquim Murtinho Miguel Burnier (operating) . At this point begins the nonoperating sections: east to Ouro Preto and north towards Sabara. Sabara line follows eastward to Santa Barbara, with operational only stretch to near Barão de Cocais. Also from Sabara, northwest, the line goes to Belo Horizonte to General Carneiro (not operating). The stretch of the General Carneiro to Horto is operational and is described in Lot 1. The excerpts included in the present document, were divided as it's showed at figure 2.

As for digital maps to be used in web GIS, these must be the same on the graphical environment, without any distinction. Therefore, the best way to analyze and represent likewise should provide the best form of interpretation and representation of information [13]. So it is necessary to teach Cartography for the visually impaired and accompany them throughout their learning process, for the reading and use of the map to be given in an optimized manner.

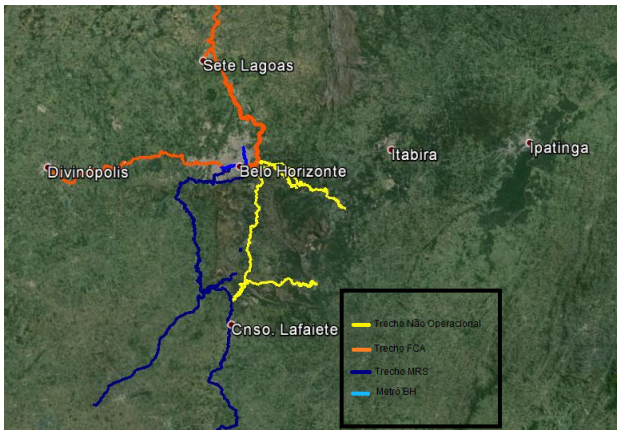


Figure 3.
Covered Excerpts – Source: Prepared by author

5. EQUIPMENT AND METHODS

The field survey was carried out by inspection of images using equipment that generates images in 360°, with a resolution suitable for examination. In excerpts Betim-Divinópolis (FCA), Betim - Prudente de Morais (FCA), Prudente de Morais - Curvelo (FCA), Jeceaba - São João del Rei (MRS), Alberto Flores- Brumadinho - Barreiro (MRS), Ibirite - Tod (MRS), Juiz de Fora – Pedra do Sino (MRS) imaging equipment was used in a 360° recording geotagging from GPS data and pointer stored in spatial database (PostGIS).

Figure 4.
Railway vehicle with camera installed.
Source: Prepared by author

To record the events detected in the images, we developed a computer system that allows the user to perform the registration of events, defined in the system database and detected in the images, characterize them and describe them with alpha-numeric data, which are connected to the respective image frames of the film where they are located. The system stores and manages to link this information with the images in the database. This developed system also allows automatic extraction is carried reports on the events section, generating reports with data, pictures and location map.
As a complement, were held footage and photos in high-resolution. This material, due to its characteristics, it is not georeferenced, but stored sequentially along portions of the data for reference. Imaging equipment used were spherical vision camera Lady Bug (6 cameras) from Point Grey Research, Sony Full HD Camcorder Sony camera and high resolution with integrated GPS system. The Figure 3 illustrates equipment spherical vision, spherical vision camera and rails.

6. FIELD RESEARCH

The teams walked the railroad tracks with the aim of raising the operating conditions of the roads with the help of the equipment listed in the previous item. The inspection and collection of images on the roads was made during time intervals provided by the utilities for the operating segments, which were done filming in 360 georeferenced. For non-operating sections, images were collected in full HD camera.
The major difference is not limited to film, but also with regard to materialization of the field reality, which, judiciously, review the images allows the passage many times as necessary in order to provide the maximum railroad engineer relevant information from images collected. The comments relating to a specific event are described only once. Thus, if the event will be repeated in other parts filmed, despite the need for correction, there will be no duplication of review.
For parts not operational, due to the difficulty of access to lines which are out of operation, the snippets Sabara - Barão Cocais, Miguel Burnier - Ouro Preto, Miguel Burnier – Barão de Cocais and extensions in the municipalities of Matozinhos, Sete Lagoas and Prudente de Morais had a different solution for lifting by images. Already parts of the inner handle Sete Lagoas and Extension of Aguas Claras in Nova Lima, although not operational, were registered by the imaging system 360º.

The survey was conducted through the events marking the route in Google Earth, through the launch of a polygon in the axis of the extinct likely via. Then the technicians were in the field, bike or on foot, to analyze site conditions and capture georeferenced images of events, according to the table defined in the system 's database, for further characterization in the laboratory of Nucletrans. It was necessary to develop a new computer system to allow the registration of such information in the database .
To register for elements of interest, applications were developed using the basic image of the Point Grey Research georeferenced spherical vision system. Thus, each element of interest are stored in a database containing information section, Latitude, Longitude (or other projection system, if necessary), frame, type of point of interest and description (if applicable). The database of final storage of alphanumeric data is the open source PostGreSQL with PostGIS.
The treatment environment and conversion of geographic data is Civil 3D that allows the manipulation of geometric data, georeferenced image manipulation and the internal module MAP, the manipulation of data from different datasources, analysis and eventual conversions projection systems formats. Figure 4 shows the screen display module for the analysis and registration of notable points .
All information generated was made available to the Agency Development Metropolitan as 360º videos generated in the passages, the database PostgreSQL/PostGIS in its latest version and can also be generated shape files (. Shp) and Google Earth (.Kml) which are generated directly from the database by another computing system developed and integrated into the site.

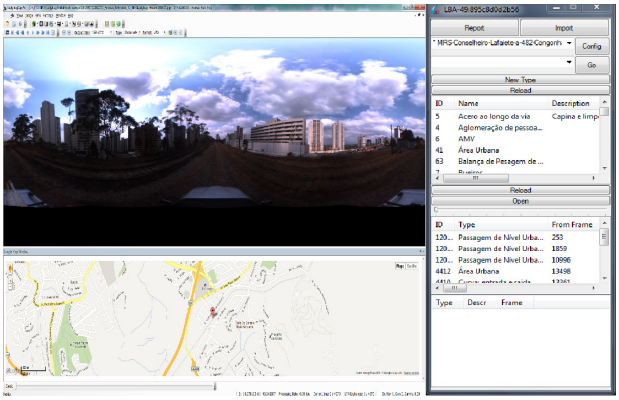


Figure 5.
Events Insertion Screen.
Source: Prepared by author

7. RESULTS

In the inspections performed were identified meter gauge (1000 mm) and wide track (1600 mm), plus some excerpts operating with mixed gauges, used especially in cargo (BRINA 1988) [12]. This impedes the movement, since the failure to be able to change the motor meter gauge to wide and vice versa causes the need for transhipment of passengers at stations between adjacent gauges.
The fixing of the track, i.e. the way in which the rails are attached to TIES of wood or recycled material was one aspect observed. There were two types of fixing: the elastic (clamps) and rigid (nails and tirefonds direct on the rail).

Besides geometry, another point that caught the attention of researchers wear was observed in the billet rails . In general, it is accepted as the wear limit a loss of up to 25% of the area of the fetlock (BRINA 1988) [13]. The results of the inspection of the images showed problems in general recurrent in all sections.

To simplify the analysis, the extracts were separated according to the dealership and reports generated according to this classification (Figure 2). Were organized in FCA, MRS and excerpts not operational (NOP). The network under concession FCA includes links Divinópolis - Railway Station Eldorado and Eldorado - Sete Lagoas. The stretches of railway operating on meter gauge (narrow) or mixed, have elastic attachment and wooden TIES. The switches and crossings (AMV) operating with drive unit for maneuvering lockable spring. Lubrication track is embedded in Rail Vehicle (VF). Level crossings (PN) in urban areas have asphalt pavement and road signs. Where there transpose traffic with larger scale, it is necessary to adopt cancels and guardhouse for traffic agent. Found railing type TR -57 and TR-68. Across the range of urban area verified the existence of clandestine crossings for pedestrians transposition.

Tracing the paths of FCA presents radius curves near the minimum, which makes the evolution of traffic in relation to speed and causes premature failure in railway superstructure, requiring the operator, the definition of a careful plan for preventive and corrective maintenance to provide adjustments and corrections of geometric features for alignment and leveling among others.

In the case of the superstructure of the roads in operation MRS and FCA, the anomalies found are concentrated on correcting the gauge, shortcomings in aligning and leveling the road race and AMV, rotten wooden TIES, excessive wear of rails, ballast out of compliance. In the case of the infrastructure, refers to embankment erosion, surface drainage system compromised portions of garbage in the rail located in urban areas and entering the bed rail.

The rail under MRS concession covers the southern part of the metropolitan region of Belo Horizonte, linking it to Sao Joao del Rei and Juiz de Fora. The route offers quality maintenance with regard to conservation of geometric characteristics of the track and control rail wear through lubrication billet, internal and external. Has broad gauge, operating in small patches in mixed gauge, elastic fixation. There is single points of slope erosion, in some places there is a commitment from the feedback of movement of trains. At these points there clogging ballast. The AMV's need interventions and control of wear safeguard quotas, with correction. Points were identified with invasion of the rail bed, rotten wooden TIES, rail erosion, trash from neighboring communities and wear of rails. Level crossings in urban areas in asphalt pavement with road signs. Urban stretches operate with high rates of vehicles crossing the railroad.

The excerpts are not operational degraded due to vandalism and the ravages of time without any maintenance for years. The main passage connects the towns of Ouro Preto and Sabara. There was disappearance of materials of railway superstructure, the rail bed occupancy by the community, and even in the transformation of local roads.

8. ANALYSIS

The study presents a new method of interpreting spatial information implemented on Google Maps for the visually impaired. The proposed model was implemented in C# language, in the framework .NET using the Google Maps API. By using Google Maps, the prototype allows the user to have access to interactive maps of the world, leading to this type of user having a new dimension of experience with geographic information. Speak Mode, developed in the prototype allows the user to create mental models from spatial topological relationships observed in Google Maps. The implemented model of topological spatial relations proved effective in experiments with blind. The experiment revealed that the mental models generated by users is similar in most cases, models actual analysis. This study demonstrates the feasibility of using geotechnology teaching and the treatment of geographic information for the blind. It presents practical and efficient results for inclusion measures for the visually impaired.

The operating system has many barriers to release of the fleet, which can cause delays and cancellations of activities. For passenger transport, it is suggested the establishment of an independent pathway used for cargo, with autonomy of movement and maneuver, as well as construction of diversion in all stations deployed, providing the operation, routes auxiliary maneuvers in cases of damage the undercarriage.

In excerpts no-operating will need to redo the study outlined for improving the geometric design. Due to the state of degradation of infrastructure and superstructure, will be required to rebuild these parts of the whole system.

Finally, it is important to highlight the importance and the method used to generate a database of georeferenced information of the entire length of the stretch, allowing the issuance of reports concerning any occurrence on the roads. The results proved consistent and assertive as the registration of the network were evaluated and used by BHMR Development Agency to determine the feasibility of implementation of passenger rail. From this, the Agency has prepared proposals for PPP's (Public Private Partnerships) in which the excerpts have been tendered for PMI - Proposed Expression of Interest [14].

9. CONCLUSION

As in most industrialized countries the passenger rail plays an important role both internally to urban centers as in the connection between them, we have experienced a revival after years of neglect. With an array of transport based solely on motorized vehicles on tires, with the fleet of private cars growing at a rate much higher than the population, Brazilian cities live an immense mobility crisis, whose solution must rely on transportation projects on rails passengers.

In this context, the Metropolitan Region of Belo Horizonte paid a high price for not having a system of high transportation capacity to serve its more than five million inhabitants. Because of development characterized by a spatial concentration of activities and equipment, it created an asymmetry conditions of use and access to urban space that discourages population segments of lower income. The PDDI [10] provides for the participation of rail to ensure a link between the centralities, existing and proposed, in a network of compatibilizing BHMR infrastructure parameters to land use that is intended.

With the shortage of resources for the implementation of modern systems transpores, efficient alternative becomes the utilization of the existing structure of the extensive rail network linking various load municipalities of BHMR and surrounding cities.

This project has the importance of contributing simplifying the process of evaluation and registration of existing railroad tracks

presenting a new methodology and equipment for data collection. He is able to assemble a georeferenced database with all the events and occurrences of a railway section. With the completion of filming georeferenced the entire stretch at 360º is possible to analyze the conditions of the stretch in the laboratory, or field trip can be done in a shorter period, recording a range much greater detail and reducing the rate rework because, once done filming, any conference can be performed using up to them, it is not necessary to return to the field.

The methodology used was valid constituting an important tool to assess viabillidade the implementation of passenger rail in the rail network MRBH.

For the future, it is an interesting improvement of the system as the coupling of sensors capable of taking measurements of some elements of the line, as the distance between the rails slips, your leveling, alignment, wear suffered, etc., determining thus its geometry. This could be achieved by laser sensors or spherical camera system could automatically recognize the elements in line and take your geometry from stereo images.

10. REFERENCES

[1] PAC RAIL, Ministry of Transport - Available in <http://www2.transportes.gov.br/bit/03-ferro/pac-ferro.html> - Accessed on 02/06/2013.

[2] TELLES, P. C. S. History of Railway Engineering in Brazil - Rio de Janeiro , RJ : Ed News & Cia , 2011.

[3] BRASILEIRO A. et al. Transportation in Brazil : history and reflections / coordination of O. Lima Neto - Brazilian DF : the Brazilian Transportation Planning / GEIPOT; Recife: Ed UFPE University , 2001.

[4] VUCHIC , Vukan R. Urban Transit : Systens and Technology. John Wiley & Sons, Inc. New Jersey. USA . 2007.

[5] Caldas , Maria F. , G. MENDONÇA Jupira of , Carmo , Lelio N. the . Urban Studies 2008 : Recent Transformations in Urban Structure - Belo Horizonte , Belo Horizonte City Hall , 2008 . Chapter 7 - Urban Mobility , p . 319-372.

[6] IBGE Census 2010. Synopsis of the 2010 Demographic Sense . Available in <www.ibge.gov.br/home/estatistica/populacao/censo2010/sinopse/sinopse_tab_rm_zip.shtm> . Retrieved on 09/23/2013 .

[7] JACOBS, Jane . Life and Death in Big Cities . Ed Matins sources . São Paulo, SP . 2000.

[8] IBGE Census 2010. Vehicle Fleet in Belo Horizonte. Available at <http://www.ibge.gov.br/cidadesat/xtras/temas.php?codmun=310620&idtema=69&search=minas-gerais|belo-horizontelfrota-2010>. Retrieved on 09/23/2013.

[9] MINISTRY OF CITIES . Integrated Management of Urban Mobility . Training Course - Notebook 1 . 2006. available in

[10] PDDI - MRBH - Integrated Development Plan of the Metropolitan region of Belo Horizonte. Minas Gerais Minas Gerais Government. In 2011. Volume II.

[11] PLAMOB - Notebook Reference for the Preparation of an Urban Mobility Plan . National Department of Transport and Urban Mobility . Ministry of Cities. 2007.

[12] BRINA , Helvécio L. Railroads Volume I, Chapter 2, p. 7. Editora UFMG . Belo Horizonte - MG. 1988.

[13] BRINA, Helvécio L. Railroads Volume I, Chapter 11 . Editora UFMG . Belo Horizonte - MG. 1988.

[14] MINAS GERAIS - Department of Metropolitan Management - SEGEM News . Available in www.metropolitana.mg.gov.br. (Accessed on 05/10/2013).

Complex Issues on Cyberwarfare

Eloi SENHORAS
Department of International Relations, Federal University of Roraima
Caixa postal 253. Boa Vista, RR - 69301970- Brazil

ABSTRACT

Cyber warfare has traditionally been referred to a multiplicity of cyber conflicts related not only to micro, isolated and decentralized actions or networks of cyber attacks, cybercrimes, and, cyber terrorism, but also and increasingly to centralized dynamics of state intervention in the cyberspace through cyber defense and cyber intelligence. Taking for reference the complex structures of the emergent new pattern of warfare, this article aims to address the new security threats in the national and international relations that have been spread in the cyberspace by the actions of individuals, organizations, and states.

Keywords: Cybercrimes, Cyberterrorism, Cyberwafare, Technologies of Information and Communication.

1. INTRODUCTION

This research shows that actions in the virtual space have rarely spilled impacts over the other traditional arenas of conflict such as land, sea, air and airspace due to the interface connections with the real world, despite cyberspace represents a new arena for the developments of warfare.

Trough an exploratory study it is shown that national and international borders or even limits between real and virtual world have been compressed by cyberspace as a locus of a 5th generation of conflicts where different stakeholders played by individuals, small groups, organizations, big networks, or, even countries conduct conflicts and where Security, Defense and Intelligence policies cross-over their functions against the new threats with questionable efficiency and legitimacy.

2. RESEARCH HYPOTHESIS

This research aims to answer a problem taking for granted two related hypothesis (H1 – independent variable; H2 – dependent variable. Why cyberwarfare has been a complex issue nowadays?

H1) Cyberwarfare represents a dimension of multiple cyber conflits of different nature;

H2) Changes in the warfare crack traditional security and defense concepts.

Chart 1 - **Comparative view of the warfare**

	TRADITIONAL WARFARE	**NEW WARFARE**
Characters	State	hackers; organizations.
Operational Theater	Centered	Decentered
Controller	State	novos atores empresas.
Soldier	Military Training	Civilian and military training
Threats	Symmetric	Asymmetric
Example	I, II World War, Cold War	9/11; cyber attacks
Tecnology	Large military apparatus	Autonomous units with high technology.

Source: BELLINTANI and BELLANTINI (2013). Author's Adaptation.

3. METHODS

This research has been constructed taking for reference the use of literature review on books and scientific journals in order to support an exploratory study based in a deductive logic for the apprehension of the complex issues on cyberwarfare.

4. THEORETICAL BACKGROUND

In one hand, taking for granted a multiplicity of stakeholders in the *cyberspace*, this study show that new Technologies of Information and Communication (TICs) have diminished the operational sovereignties of the countries due to the actions of free riders in the cyberspace such as *crackers* (criminal intention), *hackers* (activists, cyberterrorists and state soldiers) that turn internet into a complex problem such as an iceberg with a 20% visible web (unencrypted information) and 80% deep web (encrypted information) (PAGNANI, 2012).

In the other hand, this article discusses the State action in the cyberspace taking for reference how profound forces of warfare in the long run have structurally changed in the modern times and how the United States played a decisive role to the new trends and threats despite not always positive (SENHORAS *et* al., 2013).

First, by the 1950s, after the II World War, the construction of the Industrial Military Complex of Defense through scale and mass production of machinery and weapons for a massive warfare in a conflictive dynamics of a bipolar world split by the United States and the Soviet Union.

Second, the relative downsizing of the Armed Forces through special contracts and outsourcing, redesign of forces and capabilities in a context of not only gains of scope in the lean production of machinery but also of progressive transference of military technology to civilian use with the techno-scientific revolution of the 1980 and 1990s.

Third, the emergence of a current Security Complex of Information that has been fed by Intelligence and Espionage due to the development of cyberwarfare, and also the use of smaller and more precise machinery such as drones simultaneously to the trends of privatization of war since 9/11.

5. CONCLUSION

Throughout these discussions subsidies should be supplied for a better understanding of the complex impacts of cybernetics and informatics in the society due to the pulverization of power in a wide range of actors since the state to the individuals who are not only moved by a number of different interests but also make use of different strategies.

6. REFERENCES

[1] BELLINTANI, Adriana Iob. BELINTANI, Mauro. (2013). **A Guerra: do século XIX aos nossos dias**. Boa Vista: Editora UFRR, 2013.

[2] PAGANINI, Pierluigi. (2012). "What is the Deep Web? A first trip into the abyss". **Security Affairs**, May, 2012.

[3] SENHORAS, Eloi Martins *et* al. (2013). "O Brasil frente às ameaças cibernéticas". **Anais do X Congresso Acadêmico sobre Defesa Nacional**. Rio de Janeiro: Escola Naval, 2013.

A MODEL FOR SUPPLIER SELECTION BASED ON FUZZY LOGIC AND VECTORIAL INFORMATION RETRIEVAL

Renata Maria Abrantes Baracho
School of Information Science
Federal University of Minas Gerais
Belo Horizonte, Brazil
renatabaracho@ufmg.br

Amarildo Martins de Magalhães
School of Information Science
Federal University of Minas Gerais
Belo Horizonte, Brazil
amarildo@ufmg.br

Abstract: The motivation for the development of this research was the need of the *Instituto Federal de Minas Gerais* (IFMG) to select suppliers with different criteria on the *Sistema Integrado de Administração de Serviços Gerais* (SIASG net) *da Secretaria de Logística e Tecnologia da Informação (SLTI) do Ministério do Planejamento, Orçamento e Gestão*. Currently the selection of suppliers occurs through mandatory filters and keywords in SICAF, limiting the user search options. It is necessary to present research and solutions to optimize the process. We chose to develop a research model based on fuzzy logic which is considered to be one of the classic models of information retrieval. The relevance is calculated using term frequency rule with vectorial information retrieval. After the creation of the fuzzy model, we developed a prototype system for information retrieval to decision making. The system retrieves information suppliers by establishing a ranking according to the evaluation obtained by applying the fuzzy method. After the IFMG's validation, the result proves efficient with the use of fuzzy logic for decision-making environments with a high degree of uncertainty about the criteria and their pertinence[1].

Key-Words: information retrieval, information architecture, information management, information systems, decision making, fuzzy logic.

I. INTRODUCTION

Globalization combined with the process of digital inclusion and technology development organizations promotes a complex scenario in data management and information in Brazil. This dynamic scenario, together with the aspect of subjectivity and uncertainty and inherent in decision-making processes in the purchasing company, requires tools that provide the individual (buyer) with updated and efficient means to choose the best suppliers of a given service or product. Appropriate suppliers reduce purchasing costs and production time, increase customer satisfaction and strengthen competition (ARIKAN, 2012). Constant changes in the purchasing process characterize an environment with a high level of uncertainty in decision making. In organizations, individuals often make decisions in seeking a satisfactory alternative but not the best one. (CHOO, 2006, p. 276).

In the public sector, the data and information of suppliers are managed in the Supplier Manage System (SICAF) – *Sistema de Cadastro de Fornecedores*. The *Instituto Federal de Minas Gerais* (IFMG) uses SICAF to seek suppliers for their quotes. In Brazil, as directed by Corregedoria Geral da União (CGU) in each purchase process, it is necessary to perform a quote in search of the market price of the product or service before you start bidding through the Comprasnet System. In search of suppliers for a particular solution, SICAF offers limitations in the search criteria, as the system only allows people to query for keywords respecting mandatory fields, it is not possible to create different criteria to optimize the user's search. The IFMG needs a mechanism that is more efficient and intelligent to be able to carry out a search that allows the use of specific criteria to retrieve the best suppliers for a given solution and to support decision making in choosing suppliers.

The objective of this research is to develop a model of decision making using fuzzy logic to evaluate the specific criteria of information retrieval (suppliers) of IFMG. The use of fuzzy logic is considered one of the classic models of information retrieval in the classification of Baeza-Yates and Ribeiro-Neto, 1999. The criteria for the supplier's selection are defined, such criteria are linguistic variables forming a fuzzy model/tf-idf for decision making, retrieving the most suitable supplier for a particular solution. The criteria used in this research are **distance** (logistics) and **relevance** (tack supply line) of the user's search. The search relevance is calculated by observing the tf-idf, term frequency inverse relative frequency in the collection. From the model, we developed a prototype of a Decision Support System (DSS) called ForFuzzy which was validated by the purchasing team of IFMG. The users of the purchasing department used the tool for a few weeks and achieved better results compared to SICAF.

II. LITERATURE REVIEW

Information and knowledge have multiple definitions in different disciplines, and can be used in different ways and in different scenarios. In this study, we use the concept of Cornelius (2002, p. 394), wherein the information feed can alter the structure of knowledge in a receiver. The three uses of the information offered by Buckland (1989) consolidated the main asset of companies, the knowledge . Buckland (1989) categorizes three types of information use: Information as a process, information as knowledge and information as a thing. The information, through its interdisciplinary nature, enables the view of the informational context within companies on social and pragmatic

[1] This work is partially supported by Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG), Governo do Estado de Minas Gerais, Brazil, Rua Raul Pompéia, nº101 - São Pedro, Belo Horizonte, MG, 30.330-080, Brazil.

perspectives . Saracevic (1991) asserts that complex problems require interdisciplinary approaches and multidisciplinary solutions. The methodological features of Information Science, from different areas of knowledge, provide substantial resources and knowledge relevant to managers in organizations.

Using the right information at the right time is a significant differentiator and gives the company a competitive advantage, ie the Management of Information and Knowledge (MIK) is premise that is inherent to organizational efficiency. Davenport (1998, p.173), states that the management of information must be assumed by the organization as a functional process, dynamic and constantly evolving, which should be assigned to a case manager . Knowledge, classified as tacit (residing in people's minds, hard to be structured and transmitted) and explicit (formalized, documents, files, processes) is present in the people, processes and routines of a company, (Choo, 2006, p. 37). According to Davenport (1998, p. 175) , the information management permeates the four stages @ of @ knowledge @ management, @ which @ include determination of requirements, acquirement, distribution and use. Organizations that can to convert tacit knowledge into explicit knowledge through models and tools for systemic application reach high levels of competitiveness. The process of managing information and knowledge provides elements to aid decision making. Barcenas and Huertas (2012) argue that decision making requires individuals to have and to share knowledge in an intelligent way. Knowledge management strategies can obtain and use information in decision making.

With the growth of networks, the Internet and the volume of information, it becomes important to define the structure for information retrieval. In this context, information architecture provides the framework through a methodological and functional model to support decision making, according to Lima - Marques and Macedo (2006). These authors conceptualize information architecture as a methodology for structuring information systems applied to the information environment, this being understood as a space that integrates the context, content and user. Information systems must be supported by information architecture, the company obtains a better result when the information architecture is integrated into business processes, Davenport (1998 , p . 201). Organizations can change the environment of the individual decision-making, it's their task to create mechanisms that enable the individual to draw closer to their rationality in decisions (Choo, 2006, p.41,42).

There are fields of application in which the inaccuracy is inherent to the problem analyzed. Choo , 2006, p .276, points out that the decision process is characterized by vagueness, ambiguity, conflict over objectives and technical uncertainty. Inaccuracy can arise for a number of reasons: lack of information, incomplete and unobtainable information and partial ignorance (WU and CHANG , 2008). The classification of different types of uncertainty and possible treatments is currently a theme developed by various disciplines such as information science and logic (NICOLETTI et . Al , 1997 cited BRAÑA , 2008) . The disparity between certainty and uncertainty in decision making is immeasurable and sometimes goes unnoticed by the subject. In organizations, individuals often make decisions seeking a satisfactory alternative and not the best alternative. The implications of bounded rationality of the individual in the face of the complexity of solving organizational problems, requires a simplification of the decision-making process by the company. This work fits into the rational model of decision @ making @ proposed @ by @ Choo, @ which @ uses evaluation/performance monitoring to simplify decision-making. Figure 1 shows the Individual decision making process.

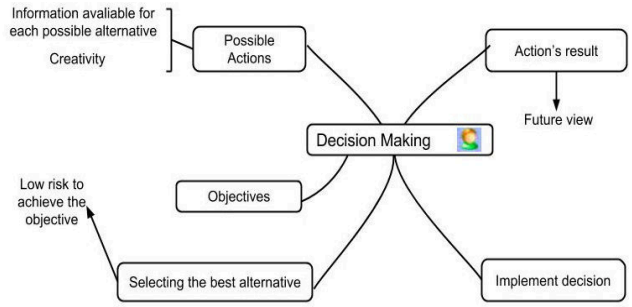


Figure 1 – Individual decision making process
Source: Adapted of Rodriguez-Barcenas and Lópes-Huertas - 2012 – p. 1456.

The expert or intelligent systems are conceptualized within the area of Information Science in the field of cognitive science and in the area of Computer Science and in the field of Artificial Intelligence. The expert or intelligent systems contextualized under artificial intelligence or cognitive science are characterized as weak Artificial Intelligence (AI), which concentrates on a set of programming techniques that make the computer run logic routines for inference. Some specialists systems are: Neural Networks, Case Based Reasoning, Repositories of Knowledge and Fuzzy Logic, Bayesian Networks. This work develops a prototype of an expert system based on fuzzy logic for information retrieval and the reduction of uncertainty in decision making. The expert systems based on fuzzy logic possess the skill of extracting conclusions and generate responses based on information that is vague, ambiguous, qualitative, incomplete or inaccurate. The Fuzzy Logic or multivalent logic is an extension of Boolean logic and admits values beteween (0) and (1).

Fuzzy logic is widely used in statistical concepts for generating inference and is intuitively easy to be used to express qualitative evaluation criteria for the decision makers (PANG and BAI, 2011). The fuzzy behavior simulates the reasoning that the expert uses rules to infer, based on information he already knows (TANSCHEIT, 2008). Fuzzy logic expresses the concept of partial truth, so that you can determine the limit values between completely true (1) and totally false (0) (BRAÑA, 2008). Figure 2 shows the linguistic variable age with the terms (young, mean, old), considered in fuzzy sets. We can say that an individual at age 22 years old is young and at the same time he's mean age. The Fuzzy Logic proposed based on membership of each element to a given set.

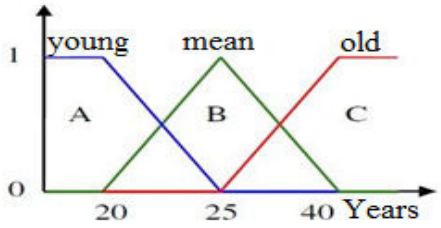


Figure 2 – Fuzzy Logic Linguistic Variables – Fuzzy Sets
Source: Tanscheit – 2008 – p. 26.

III. SICAF – SUPPLIER MANAGE SYSTEM

The Supplier Manage System (SICAF) – *Sistema de Cadastro de Fornecedores do Governo Brasileiro* is the government system maintained by the Federal Data Processing (Serpro) – *Serviço de Processamento de Dados* that keeps the updated data of all suppliers that participate in the bidding system Comprasnet. The system is available to any person or entity supplier of Brazil to register and participate in government procurement processes. The complicating factor is that the SICAF has no interface for retrieval of suppliers by keywords of the product or service with specific criteria.

In the supplier search in SICAF, the user shares information about the type of person (or entity) and the state in which you want to filter suppliers and supply lines . Thus, if the user wants to find all suppliers in Brazil working with "Information Security", for example, he should do 27 searches for the 26 states plus the Federal District and manually add all supply lines containing related services to his research. SICAF display order of results alphabetically and the distance criterion is not considered. Despite the fact that SICAF does not have efficient means of searching, it has an Application Program Interface (API), which allows access to data in it's database through webservices. The initiative of opening up access to data is part of the Open Data movement that emerged as a social demand for greater transparency, collaboration and participation of citizens in government policies and actions (ALVES and SOUZA, 2010). Making use of Open Data is possible to create applications that integrate and use government data.

IV. IFMG PURCHASE PROCESS

In IFMG, the process begins with the request coming from the sector wishing to purchase a service or product. When the purchasing department receives a purchase request, the phase for quotations is iniciated. Before the product or service may be inserted in Comprasnet, you must perform three quotations from suppliers preferably registered in SICAF, the goal is to determine the average price of the product or service for inclusion in the bidding process in Comprasnet. The *Controladoria Geral da União* (CGU) indicates three suppliers as the minimum number to be quoted, but this number can be higher depending on the buyer. The choice of these suppliers is the responsibility of each public agency. For IFMG, the distance criteria is considered important in the selection of suppliers, as experts say, this criterion is a likely facilitator of purchase, the closer the supplier, the greater the possibility of efficient logistics. When the process is effected in the form without bidding, the search of suppliers is even more important because the first supplier could be the winner of the bid and the purchase is done in a straightforward manner.

V. FUZZY TF-IDF MODEL AND PROTOTYPE

Given the difficulty in locating suppliers determined by the solution IFMG's selection criteria and the impossibility of inserting specific criteria to search for suppliers in SICAF, we concluded that it would be necessary to carry out the development of a model based on fuzzy logic for decision applied to a decision Support System (ForFuzzy) followed by the case study through a validation IFMG.

From considerations about scientific research, Lakatos and Marconi (1991), this research is classified in nature as it is **Applied** to generate results of practical application in organizations and based on the problem as **Qualitative**, considering that the model development can not be measured quantitatively and uses quality criteria for inference in decision making.

Determination of criteria

The two criteria chosen for model validation in IFMG were **distance** and **search relevance**. These criteria are used as input values of the fuzzy logic model and the end result (supplier evaluation) is based on that input.

Distance calculation based on the geographical position:

SICAF contains the geographic coordinates for the address of each supplier. To calculate the distance, we used the source address that the user entered in ForFuzzy and the address of the supplier in the database as a destination. It was created as a function in ForFuzzy using the Google Maps API to automatically fetch the coordinates of each supplier according to your address. The ForFuzzy has a parameter to select whether you want to perform the distance calculation by Google Maps or not. Google calculates the distance on the right way, ie, considering the Brazilian road map, but it was reported that Google Maps has a limitation of 2500 queries per day. In the case of Google being unavailable, the calculation could be performed using Haversine formula, which uses trigonometry to calculate the navigation altitude of a celestial body and to determine the position of a ship or airplane (ROBUST 1957).

Calculation relevance search:

Each supplier has their supply lines in their registration, ie in which business segments are they inserted and which categories of products and services provided, this information

is stored in the ForFuzzy database. When the user performs a search for a product or service, the system queries the information in the database to verify the validity of the supplier with respect to the user query. The user has a field to perform the search, and can enter up to 50 characters.

For information retrieval, the ForFuzzy uses three techniques to perform the search in the database, the first is the technique of removing stop-words in the user's query, prepositions and conjunctions are removed from the terms entered by the user. Words not considered informative like (to, from, in, in, a, an), also known as stop-words are often ignored (SINGHAL, 2001). The second technique used is the concept of case-isensitive, which performs the search in word uppercase and lower case letters, accents are also disregarded. Thirdly, the Forfuzzy uses a search vector based on the TF - IDF - the term frequency inverse. In the TF - IDF the frequency of the term in a document and a collection is taken into account (SINGHAL, 2001). The TF - IDF was applied to the system through MySQL database functions MATH and AGAINST using FULLTEXT index as the supplier name and his supply lines. The system calculates the frequency of each supplier through the search query informed by the user and based on (supplier name and/or supply line). The relevance is calculated based on the number of words in a row, the number of unique words in a row, the total words in a collection, and the total number of suppliers that contains a particular word. The user can perform an exact search, to do that, it is necessary to include the words between quotes, eg "electrical engineering services."

Suppliers's score

For each returned supplier, the system assigns a 21:23 score points for each word fetched that exist in their supply line. The system checks the individual words typed by the user and the supplier punctuates every word found in their supply line. The system also checks the complete expression informed by the user, and if it finds the expression in the same way, it gives an extra value: 31.23. These values take into account the ranges of relevance criteria of fuzzy logic. The ForFuzzy only considers the result to the suppliers that they have a score greater than zero on relevance criteria. The calculation also considers the relevance score decreased to vendors that provide virtually any product or service.

Fuzzy Logic Model

The two criteria assumed for this research (distance and relevance) are input variables for the fuzzy/tf-idf model. Each variable is assigned membership functions in a process called Fuzzification, then the fuzzy rules are applied, this is the inference step, which reflects part of the externalization of the knowledge of experts and last step is performed Defuzzication that converts fuzzy values into crisp values. The model receives real values (crisp), processes the steps of fuzzy logic and as a result regenerates other real values (crisp). The model uses the concept of Multiple Input Simple Ouput (MISO), ie, entering the relevant search and distance variables and results evaluation (AMENDOLA, SOUZA and Barros, 2005). Figure 3 shows the architecture of fuzzy logic used.

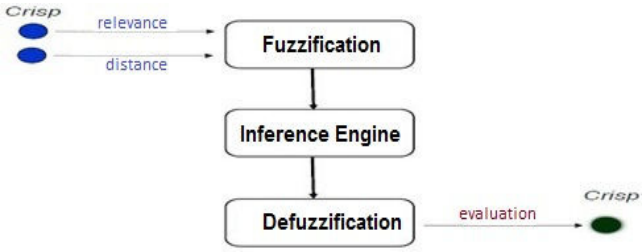


Figura 3 – Fuzzy Logic Architecture – supplier's selection
Source: Create by the authors.

Fuzzification

The fuzzification is the process of the mathematical modeling of the values of the input variables (criteria) through the fuzzy sets, ie, transforming the real values (crisp) into linguistic values. The IFMG purchase team participated actively in this phase to build the model of membership variables. For each variable it is necessary to define linguistic terms and assign a membership function, each input value will have a degree of membership in each of the fuzzy sets.

The **input variable distance** obtained linguistic terms **short**, **medium** and **long** as fuzzy sets created by experts. According to the purchase team, there may be differences in how the membership functions act under distance criteria, therefore, it was created in ForFuzzy a mechanism for choosing the distance value. According to the distance chosen by the user, the system changes the scale membership function. Maximum values of distance variable can be 50, 100, 300, 500 and 1000 kilometers. The fourth graph shows the membership functions of the variable distance considering user's choice of 100 km for the calculation.

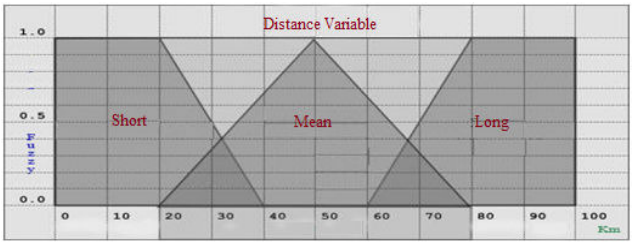


Figure 4 – Membership Functions – distance criteria
Source: Adapted from NEGNEVITSKY, 2005.

The linguistic terms Short, Medium and Long are considered fuzzy sets. In the chart above, distances up to 20 km represent 1 degree of membership in fuzzy set 'Short', the degree of membership in this group decreases as the distance increases. In the range of 20 to 40 km there is an intersection between the Short and Medium sets, each value in this range belongs to both sets. The most common shapes used for membership functions are triangular (trimf), trapezoidal (trapmf) and Gaussian (gaussmf) (AMENDOLA, SOUZA and BARROS, 2005). In this work due to the object of study, the membership functions used for variable distance were sequentially Trapezoidal, Triangular and Trapezoidal.

The **input search relevance variable** obtained the membership linguistic terms (**low** and **high**) using the trapezoidal membership functions. The score of each criteria in supplier search relevance can go up to 100 points. You can enter your search through a field with 50 characters. The figure 5 shows the graph with the membership functions of the variable relevance.

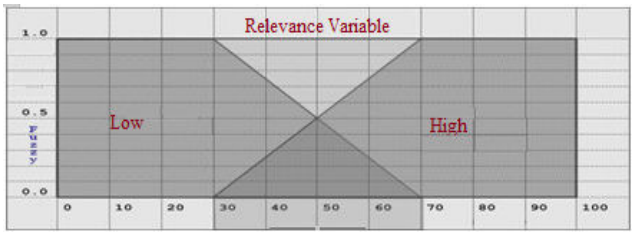


Figura 5 – Membership Functions – search relevance criteria
Source: Adapted from Negnevitsky, 2005, p. 93.

The output variable **evaluation** is calculated by the fuzzy tf/idf model based on inputs, its output can be classified into 5 options (**Poor**, **Fair**, **Good**, **Better** and **Best**).

Knowledge Base – Inference

At this stage, the expert's knowledge (tacit) is converted into explicit defining inference rules for the fuzzy tf/idf model. The literature presents two inference methods, the Mamdani and Sugeno-Kang-Takgi, the basic difference between the two is the type of response and the procedure of fuzzification, (GANGA and CARPINETTI, 2011). This work uses the Mamdani method, which includes features that make input variables equivalent fuzzy sets and subsequently fuzzy variables into numerical variables, proportionately suitable for use in the ForFuzzy System (MAMDANI, 1974).

Defuzzification

The defuzzification process is the conversion of the values obtained from the fuzzy step interference in crisp values (real) that can be used in ForFuzzy, the qualitative result generated by the output variable values is converted in quantitative evaluation. There are several defuzzification methods, such as: Mean of Maximum (MOM), Centroid-center area, Smallest of maximum @ value, @ Maximum @ value @ of @ maximum (NEGNEVITSKY, 2011). In this study, we used the method of the Mean of Maximum which consists in taking the maximum membership fuzzy values axis (y axis) and the maximum membership crisp values axis (x axis) of evaluation. For each crisp value, checks the value corresponding to fuzzy the shaft, the end result is the average of the maxima of the two axes.

ForFuzzy System Prototype

The Decision Support System ForFuzzy was developed for the purpose of applying the fuzzy/tf-idf model for validation of the problem of suppliers searching of IFMG. The ForFuzzy was developed in PHP language and MySQL database. The system is hosted at www.ecot.com.br/forfuzzy/ and uses the Apache web server to manage requests. The system allows filtering by state, by supplier and by distance. The system architecture is designed in a similar way to existing models of web searchers. The database is integrated with ForFuzzy and SICAF @ through @ Webservice http://api.comprasnet.gov.br/sicaf/v1/consulta/fornecedores.xml.

VI. RESULTS

The results obtained with the application of fuzzy logic in supplier selection problems were relevant to IFMG. Through the fuzzy/tf-idf model it is possible to approach more search results according to the needs of IFMG. Tests were performed on the system ForFuzzy aiming to ascertain and certify the effectiveness of fuzzy logic in relation to the standard query method available to IFMG. Below is shown an example of a query in the standard (SQL query only simulating the SICAF behavior) and the fuzzy/tf-idf model. For this example, we sought the suppliers who have in their name the word **technology** and in its business segments the expression **information security**. Table 1 below displays the query results in the Normal Model. Table 2 displays the query results in fuzzy/tf-idf model. Note that the fuzzy/tf-idf model has high relevance to the criteria chosen in the search.

Table 1 Normal model results (simulating SICAF's search)

Supplier m	Distance (km)	Relevance (tf-idf)	Evaluation
Fix @ Informatica, Treinamento @ e Consultoria	0.627 @	20.43 @	490664
Yes Solucoes em Seguranca @ e Tecnologia	1.039 @	20.48 @	484586
BizMart Tecnologia da Informacao	3.033 @	20.48 @	455881

Source: Created by the authors.

Table 1 Fuzzy/tf-idf model results

Supplier m	Distance (km)	Relevance (tf-idf)	Evaluation
Allen bh servicos e comercio de produtos de informatica	6.771 @	38.41 @	76.2249830
Alvo seguranca @	7.207 @	36.61 @	75.1788280
Fatima honorato aguiar	10.107 @	34.61 @	73.8772027

Source: Created by the authors.

Supply lines has equivalent and approximate terms, the vectorial search using term frequency enables the user to retrieve more relevant suppliers according to his query.

In the normal model, the evaluation was calculated considering the distance and relevance based on the classic sets. The query also used the calculation of variable tf-idf relevance. In Table 1, we can observe that the ForFuzzy returned the supplier **Fix Informatica, Treinamento e Consultoria** in the first place, even this having a lower relevance than others. The value of each variable is assigned exclusively to one set, both for the variable distance and

relevance.

The maximum distance considered in the example was 50km. The supplier, whose distance is less than 21km (limit set **short** and **mean**) receives membership full (1) to the set short. In this example, as the distance has greater weight and all suppliers received membership 1 in the **Low** classic set for the variable search relevance, the prevailing criterion for calculating evaluation was the distance. All the results given in table 1 got the same value to search relevance in the classical low set.

In fuzzy/tf-idf model, the evaluation was calculated considering the distance and search relevance based on fuzzy sets. In Table 2 we can observe that the supplier **Allen bh servicos e comercio de produtos de informatica** got better ratings than the others, despite having a slightly larger distance than the top finishers on the normal model. The degree of membership plays a critical role as the relevance of the first supplier is more appropriate to **high** set than the relevance of others. With the range of the short distance up to 21km example, both suppliers took a value relevant in Short set and due to the fact that their relevance is larger, they got closer to the actual values. In this case, the system use scales to compute the results.

Although all suppliers possess the desired product in their supply lines, the first place in fuzzy/tf-idf model has greater adhesion according to specific criteria IFMG. Therefore, the fuzzy/tf-idf model all variables are considered assuming values relevant to the sets and thus enabling them to be closer to real values through a true intensity . This study used only two input variables that were not of a high complexity involved in the decision making process, however, the more variables are involved in the process, the greater is the complexity of the decision, the level of uncertainty and this becomes the most appropriate use of fuzzy logic.

VII. CONCLUSION

This paper has used fuzzy logic and term frequency to generate a model for optimized search suppliers. The model was applied within to Decision Support System called ForFuzzy and validated at the *Instituto Federal de Minas Gerais* (IFMG). The result proved to be efficient with the use of fuzzy logic for decision-making environments with a high degree of uncertainty about the criteria and their pertinence, however, also noted that the application of fuzzy method is most suitable and appropriate when many criteria are used for selection. The results show that the fuzzy logic, approximates the results of the real model, which considers uncertainties, imperfections and constant change.

Fuzzy logic is presented as a concept widely used in decision making. The application of fuzzy models is present in several areas such as system optimization, improvements in the process of information retrieval and especially decision-making. The use of fuzzy logic with vectorial information retrieval based on term frequency inverse frequency brings the user the ability to retrieve documents more relevant according to his query and to control the uncertainty about several criteria in decision making process.

Knowledge management is a key factor in decision-making. If the tacit knowledge of experts are being outsourced and converted into explicit and applied to decision-making processes as the systemic model of fuzzy logic, surely the company creates ways to replicate the knowledge between individuals and possibly achieve a multiplication potential of effective knowledge.

VIII. REFERENCES

[1] ARIKAN, F. A fuzzy solution approach for multi objective supplier selection. **Elsevier**, Industrial Engineering Department, Faculty of Engineering, Gazi University, 06570 Ankara, Turkey, 2012.

[2] AMENDOLA, M.; SOUZA, A. L.; BARROS L.C. User's manual of the theory of fuzzy sets in MATLAB 6.5, 2005.

[3] ALVES, T.R.; SOUZA, C. A. Procurement electronic government: an assessment of sites of e-procurement of brazilian state governments, USP, São Paulo, 2010.

[4] BAEZA-YATES, R.; RIBEIRO-NETO, B. Modern Information Retrieval. New York: **ACM Press**, 1999. 511p.

[5] BRAÑA, J. P. Decision making process in project exploration and production of oil: a systemic approach with application of the theory of fuzzy logic. Rio de Janeiro: UFRJ, 2008.

[6] BUCKLAND, M. Information as Thing.School of Library and Information Studies, **Journal of the American society for information science**.University of California, Berkley, 1989.

[7] CHOO, C.W.; ROCHA, E. The organization of knowledge: how organizations use information to create knowledge, build knowledge and make decisions. São Paulo: **SENAC**, 2006, Cap.1.

[8] CORNELIUS, I. Theorizing information for information science.**Annual review of information science and technology**, American Society for Information Science, v. 36, p. 393–425, 2002.

[9] DAVENPORT, T. H.; PRUSAK, L. Business Knowledge: How organizations manage their intellectual capital. São Paulo: **Elsevier**, 1998. Cap. 7.

[10] DETLOR, B. Information Management. International Journal of Information Management.**Elsevier**, 2009.

[11] ERDEM, AslıSencer; GOÇEN, Emir.Development of a decision support system for supplier evaluation and order allocation. Istanbul, Turkey: **Elsevier**, 2011.

[12] GANGA, G. M. D.; CARPINETTI, L. C. R. A Fuzzy Logic Approach to Supply Chain Performance Management, São Carlos, **Elsevier**, 2011.

[13] LAKATOS, E. M.; MARCONI, M. A. Fundamentals of scientific methodology. 3ed. São Paulo: **Atlas**, 1991.

[14] LIMA-MARQUES, M.; MACEDO, F. L. O. de. Information architecture: basis for A knowledge management. In: TARAPANOFF, K. O. (Ed.). Intelligence, information e cognition. Brasília: **IBICT**, 2006. P. 241-255.

[15] MAMDANI, E.H. Application of Fuzzy Algorithms for Control of Simple Dynamic Plant. **IEEE** (Control and Science), v.121(12), p.1585-1588, 1974.

[16] NEGNEVITSKY, M. Artificial Intelligence: A Guide To Intelligent Systems. **PearsonEducationLimited**. Edinburgh Gate Harlow, Essex CM20 2JE England, 2005.

[17] PANG, B.; BAI, S. An integrated fuzzy synthetic evaluation approach for supplier selection based on analytic network process. China: **Springer**, 2011

[18] RODRIGUEZ-BARCENAS, G; LÓPES-HUERTAS, M. J. Sati's Analytic Hierarchies Method for Knowledge Organization in Decision Making.**Journal of the American Society for Information Science and Technology**, 2012.

[19] SARACEVIC, T. Information Science: Origin, evolution and relationships. School of Communication, **Information and Library Studies**, Rutgers University, 1991.

[20] TANSCHEIT, R. Fuzzy systems. Rio de Janeiro: PUC, 2008.

Analytic Hierarchy Process (AHP) in ranking rainfall stations in-filled with Radio Basis Function Artificial Neural Networks (RBFN)

Masengo Ilunga
Department of Civil Engineering & Chemical Engineering,
University of South Africa,
Pretoria, South Africa.
E-mail: ilungm@unisa.ac.za

ABSTRACT

Analytic Hierarchy Process (AHP) is used for the selection (suitability) of the rainfall stations when the Radio Basis Function Neural Network (RBNN) is used to infill rainfall data as obtained from the literature. This is illustrated through selected rainfall stations i.e. Shafeera (SH); Klein Australie (KL); Tshakhuma (TS); Elim (EL); Palmaryvile (PA) in the Luvuvhu River Catchment (LRC) of South Africa. In the AHP formulation, statistical indicators such as Root Mean Square Error of Predictions (RMSE), the Nash-Sutcliffe (NSE) and percentage of bias (PBIAS) are used as low level criteria while calibration and validation are the high level criteria. Based on a constituent judgment, pairwise comparisons carried out through AHP showed that the overall rankings of the rainfall stations KL, TS, EL, SH, PA were 24 %, 24 %, 24 %, 14 % and 14 % respectively. Hence, KL, TS and EL are highly equally suitable for rainfall data infilling process while SH and PA have relatively low equal preference.

Keywords: Analytic hierarchical process, rainfall station, ANN

1. INTRODUCTION

Rainfall data as many hydrological data play a major in water resources planning and development. Quite often missing values are found in rainfall time series. Infilling data techniques such as ANNs can be used for rainfall data [1], [2], [7] and are compared using statistical indicators for example. However, it is very rare to assess the preferences that the modeler or water resource manager will have for a set of rainfall stations. For this end, AHP can be used as a multi-criteria decision making tool to rank rainfall stations for the purpose of infilling data process. The literature on such a ranking in particular for rainfall stations does not exist. A similar attempt was made recently for ranking watersheds for streamflow data infilling data [3]. The choice for suitable rainfall stations may not be easy when considering several selection performance criteria, which may lead to judgment subjectivity in the AHP formulation. The judgment consistency for AHP is carried out by computing the consistency ratio (CR), which should be less than 1. In the current study, AHP is formulated based on a previous study [1], where BFNN was applied for the purpose of filling-in missing daily values at rainfall stations in the LCR of South Africa. For more details, the reader can be referred to [1]. In what follows "model" and "technique" can be used interchangeably.

2. AHP AND RAINFALL DATA INFILLING

AHP was approached for the first time as a multi criteria decision-making tool, by Prof. Thomas L. Saaty in the 1980's [8]. This technique has been applied to several disciplines [5], [6] and recently to streamflow infilling data related problems [3], [4]. However, the literature on AHP applied to rainfall data infilling problems is almost inexistent. The use of AHP in engineering problems can be a powerful tool when comparing different alternatives. During decision making process, AHP enables to formulate transparently a complex problem into a hierarchy which is often comprised of the following level:
-Goal
-Criteria (e.g. High level criteria and low level criteria)
-Alternatives
AHP is carried out through several pairwise comparisons based on a 1 to 9 scale. The goal is achieved through a set of criteria. Therefore 1: displays equal preference between elements; 3: moderate preference; 5: strong preference between elements; 9: extreme preference between elements. The numbers 2, 4, 6 and 8 are used as intermediate values for pairwise comparisons. There are several studies that give details about AHP methodology, e.g. [5], [6], [8]. No study has investigated so far AHP application for rainfall station selection in data infilling problems.

3. APPLICATION AHP FOR RAINFALL STATION RANKING

Data availability

As mentioned previously, rainfall data used in this study has been extracted from the literature [1] where RBFNN was used to fill in rainfall data [1]. Rainfall stations belong to LRC of South Africa and details for rainfall station inputs during missing data process can be found from the same literature. In the current study, data in Table 1 has been extracted from [1] and is used in AHP formulation and implementation. Table 1 displays the values of the different statistical indicators during calibration and validation at different rainfall stations in LRC when rainfall data infilling model (RBFN) has been used.

Table 1. Performance of RBFN during calibration and validation at different rainfall stations in LRC, data extracted from [1]

Rainfall station name	RMSE		NSE		PBIAS	
	Calibration	Validation	Calibration	Validation	Calibration	Validation
SH	6.93	4.23	0.72	0.50	21.53	17.43
KL	5.30	7.50	0.80	0.67	8.06	1.43
TS	4.16	5.51	0.72	0.49	10.94	14.30
EL	7.59	0.91	0.68	0.95	12.95	20.10
PA	6.92	5.3	0.60	0.54	9.61	20.1

AHP formulation and implementaion for rainfall station ranking

From Table 1, the formulation of AHP can be presented as follows:

- Goal: Deciding on the ranking of rainfall stations.
- High level criteria: Calibration and validation periods
- Low level criteria: statistical indicators: RMSE; NSE and PBIAS
- Alternatives: these are rainfall stations; i.e. KL, TS, EL, SH and PA

The above is applied with regard to RBFN model.

Pairwise comparsion of low level criteria

Low level criteria (RMSE; NSE and PBIAS) were used to determine the judgment matrix for AHP. More preference was subjectively put on RMSE criterion than the rest of criteria as far as the accuracy of streamflow prediction was concerned [3]. Similarly, for the purpose of the accuracy of infilled rainfall data series, RMSEp is considered subjectively to be moderately preferred over NSE and PBIAS respectively when carrying out pairwise comparisons among statistical criteria. In addition, NSE was considered to be moderately preferred over PBIAS for pairwise comparisons between NSE and PBIAS. Table 2 summarizes pairwise comparisons. In this case, the subjectivity in the pairwise comparisons among low level criteria was shown to be acceptable since the computed consistent ratio (i.e. CR = 0.031) was less than 0.1.

Table 2 Pairwise comparison of low level criteria (RMSE, NSE, PBIAS)

	RMSE	NSE	PBIAS
RMSE	1	2	2
NSE	0.5	1	2
PBIAS	0.5	0.5	1

Pairwise comparison of high level criteria

The high level criteria, i.e. calibration and validation periods are considered to have equal importance or preference as depicted in Table3.This can be explained by the fact model performance is assumed to have equal weight irrespective of the period. Hence a value of 1 is shown as preference for both Calibration and validation.

Table 3. Pairwise comparison of high level criteria

	Calibration	Validation
Calibration	1	1
Validation	1	1

Alternative pairwise comparisons

Pairwise comparisons were carried out among the different rainfall stations with respect to statistical indicators and are summarized in Table 4a, 4b and 4 c for the calibration period. Similar tables were also obtained for the validation period, however they are not displayed here. Recall that the only rainfall data infilling technique is the RBFN.

Table 4a. Pairwise comparison among rainfall stations with respect to RMSE (calibration)

	SH	KL	TS	EL	PA
SH	1	0.33	0.2	3	1
KL	3	1	0.33	5	3
TS	5	3	1	7	5
EL	0.33	0.2	0.14	1	0.33
PA	1	0.33	0.2	0.33	1

Table 4b. Pairwise comparison among rainfall stations with respect to SSE (calibration)

	SH	KL	TS	EL	PA
SH	1	0.2	1	3	7
KL	5	1	0.14	7	9
TS	1	7	1	7	7
EL	0.33	0.14	0.14	1	5
PA	0.14	0.11	0.14	0.2	1

Table 4c. Pairwise comparison among rainfall stations with respect to PBIAS (calibration)

	SH	KL	TS	EL	PA
SH	1	0.11	7	5	4
KL	9	1	3	5	2
TS	0.14	0.33	1	3	0.5
EL	0.5	0.2	0.33	1	0.33
PA	0.25	0.5	2	3	1

4. RESULTS AND DISCUSSION

Table 5 displays the low level criteria weights computed from Table 2. The results in this table (last column) showed that 49 % of preference is on RMSE followed by NSE with 31 % and by PBIAS with 20 %. The preference is approached from the goal perspective of the hierarchy. The results obtained are more dependent on the pairwise comparisons carried out previously. The consistency ratio was less than 1 as outlined previously and these results are acceptable.

Table 5. Weight of low level criteria

	RMSE	NSE	PBIAS	Weights
RMSE	0.50	0.57	0.40	0.49
NSE	0.25	0.29	0.40	0.31
PBIAS	0.25	0.14	0.20	0.20

For calibration period, the weight of alternatives (rainfall stations) with respect to the low level criteria were computed and summarized in Table 6a, 6b and 6c. Similarly, calculations of weights of rainfall stations for validation period were carried out and presented in Tables 7a, 7b and 7b of Appendix A.

Table 6a. Weights of rainfall stations with respect to RMSE for calibration period

	SH	KL	TS	EL	PA	Average
SH	0.10	0.07	0.11	0.18	0.10	0.11
KL	0.29	0.21	0.18	0.31	0.29	0.25
TS	0.48	0.62	0.53	0.43	0.48	0.51
EL	0.03	0.04	0.08	0.06	0.03	0.05
PA	0.10	0.07	0.11	0.02	0.10	0.08
	1	1	1	1	1	

Table 6a. Weights of rainfall stations with respect to NSE for calibration period

	SH	KL	TS	EL	PA	Average
SH	0.13	0.02	0.41	0.16	0.24	0.20
KL	0.67	0.12	0.06	0.38	0.31	0.31
TS	0.13	0.83	0.41	0.38	0.24	0.40
EL	0.04	0.02	0.06	0.05	0.17	0.07
PA	0.02	0.01	0.06	0.01	0.03	0.03
	1	1	1	1	1	

Table 6c. Weights of rainfall stations with respect to PBIAS for calibration period

	SH	KL	TS	EL	PA	Weights
SH	0.09	0.05	0.53	0.29	0.51	0.29
KL	0.83	0.47	0.23	0.29	0.26	0.41
TS	0.01	0.16	0.08	0.18	0.06	0.10
EL	0.05	0.09	0.02	0.06	0.04	0.05
PA	0.02	0.23	0.15	0.18	0.13	0.14
	1	1	1	1	1	

Each element in Table 6a (weights of rainfall) is obtained by dividing the entry in Table 4a (preference on criteria) by the sum of the column it appears in. Values in the Average column are obtained by averaging values in the different rows. The average column (last column) represents the weights of rainfall stations with respect to RMSE only. Similarly, weights of rainfall stations with respect to NSE and PBIAS can be obtained in Tables 6b and 6c.

The comparison rainfall weights with respect to RMSE and NSE (Tables 6 a and 6 b, except Table 6c) displayed the same trend for the first 3 most preferred rainfall stations, i.e. TS, KL and SH. This is in line with rainfall data infilling process. According to Table 6a, 6b, the modeler or decision-maker will prefer more to use data from TS, KL and SH rainfall stations for rainfall data infilling process. Then the choice will be on PA and EL rainfall stations (Table 6a) or the choice will be on EL and PA (Table 6b). However, for Table 6c, when the PBIAS criterion is considered for weight of alternatives, the decision-maker will give more preference for KL, SH and PA, then followed by TS and EL. It can be observed that in any case, the rainfall station EL has been ranked among the last 2 preferences during calibration.

During validation period (Appendix A), it has been observed that that EL rainfall station is highly ranked (53 %) according to Tables 7a and 7b while it is ranked last (5%) at the same level of preference as PA rainfall station according to Table 7c.

For each period (calibration/validation), the weights for different rainfall stations vary from one criterion to the other. Hence the decision maker choice on rainfall stations will be influenced based on criteria used as well set of data used, i.e. calibration and validation.

The overall preferences (weights) for the rainfall stations are displayed in Appendix B, specifically in Table 8. The overall weights take simultaneously into account calibration and validation periods as well as all low level criteria. This is done in line with the main objective of AHP. The results showed that SH and PA displayed the same level preference (i.e. 14 %) while TS, KL, EL have a preference of 24 % each. Hence the decision maker or the modeler or user will prioritize first these last three rainfall stations, then SH and PA as far as rainfall data infilling process is concerned. This ranking is only valid for the application of rainfall data infilling at LRC, in South Africa. The results are only limited to the set of statistical criteria as well as RBFN that have considered for this study. More criteria, rainfall stations and infilling data techniques could have influenced the decision-making process for rainfall station infilling process.

5. CONCLUSIONS

It has been shown for the first time that AHP can be applied to the selection of the rainfall stations for data infilling problems by considering both calibration and validation periods. The ranking/selection was made through a consistent judgment, rather than relying on a rule of thumb. The overall preferences of rainfall stations were TS, KL, EL (24 % each) and SH, PA (14 % each) specifically for LRC in South Africa. This could help the decision-maker in selecting rainfall stations for the purpose of data infilling process. Once again the versatility of the AHP methodology has been shown through this study. This study is limited to only one technique. Further work could include application of AHP to more rainfall stations with more statistical criteria as well as ANNs other than the RBFN. Other catchments may be explored as well.

ACKNOWLEDGMENTS

The author acknowledges the use of data extracted from Odiyo, J. O and Nkuna' publication used as basis in the formulation of AHP

6. REFERENCES

[1] Odiyo, J. O and Nkuna, T.R, "Filling of missing rainfall data in Luvhuvhu River Catchment using artificial neural networks", **Physics and Chemistry of the earth**, Vol.36, issues 14-15, 2011, pp. 711-1208.

[2] Ilunga, M., "Infilling Annual Rainfall Data Using Feedforward Backpropagation Artificial Neural Networks (ANN): Application of the Standard and Generalized Backpropagation Techniques**", Journal of the South African Institution of Civil Engineering**, Vol. *52*, No. 1, 2010, pp. 2-10

[3] M. Ilunga and E.K. Onyari, "Application of Hierarchical Process (AHP) for ANN model selection in streamflow prediction", **World Multiconference on Systemics, Cybernetics and Informatics** *(WMSCI 2011)*, Orlando, USA, July 19 th-22 nd, 2011.

[4] Ilunga, M. "Analytic hierarchy process (AHP) in ranking watersheds for streamflow data infilling models", **The 17 th World Multi-Conference on Systemic, Cybernetics and Informatics** *(WMSCI 2013)*, USA, Orlando, July 2013

[5] Duke, J.M & Aull, H., "Identifying public preferences for land preservation using the analytic hierarchy process", **Ecological Economics** 42, 2002, pp. 131-145.

[6] Young, K. D, Yamin, Y., Dymond, R.L., "Applications of the Analytic Hierarchy Process for selecting and modelling stormwater best management practices", **Journal of Contemporary Water Research & Education**, Issue 146, 2010, pp. 50-63.

[7] T. W. Kim, H. Ahn, **Spatial rainfall model using a pattern classifier for estimating missing daily rainfall data**, **Stochastic Environmental Research and Risk Assessment**, Vol. 23, 2009, 367-376.

[8] Saaty, T.L. The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation, ISBN 0-07-054371-2. McGraw-Hill, 1980.

7. APPENDICES

Appendix A: Determination of alternative Weights for validation period

Table 7a. Weights of rainfall stations with respect to RMSE for validation period

	SH	KL	TS	EL	PA	Weight
SH	0.09	0.19	0.21	0.18	0.05	0.14
KL	0.02	0.05	0.04	0.06	0.04	0.04
TS	0.05	0.14	0.11	0.13	0.07	0.10
EL	0.56	0.43	0.43	0.53	0.71	0.53
PA	0.28	0.19	0.21	0.11	0.14	0.19
	1.00	1.00	1.00	1.00	1.00	1.00

Table 7b. Weights of rainfall stations with respect to NSE for validation period

	SH	KL	TS	EL	PA	Weight
SH	0.05	0.02	0.07	0.07	0.03	0.05
KL	0.26	0.09	0.01	0.12	0.38	0.17
TS	0.05	0.44	0.07	0.07	0.03	0.13
EL	0.47	0.44	0.63	0.62	0.47	0.53
PA	0.16	0.02	0.21	0.12	0.09	0.12
	1.00	1.00	1.00	1.00	1.00	1.00

Table 7c. Weights of rainfall stations with respect to PBIAS for validation period

	SH	KL	TS	EL	PA	Weight
SH	0.09	0.09	0.05	0.17	0.17	0.11
KL	0.60	0.64	0.73	0.50	0.50	0.59
TS	0.26	0.13	0.15	0.22	0.22	0.20
EL	0.03	0.07	0.04	0.06	0.06	0.05
PA	0.03	0.07	0.04	0.06	0.06	0.05
	1.00	1.00	1.00	1.00	1.00	

Appendix B: Determination of overall weights

Table 8. Calculation of overall weights of rainfall stations

Rainfall station	Calibration [0.5]			Verification [0.5]			Overall weight
	RMSE[0.49]	NSE[0.32]	PBIAS[0.19]	RMSE[0.49]	NSE[0.32]	PBIAS[0.19]	
SH	0.111	0.195	0.295	0.144	0.048	0.111	0.14
KL	0.254	0.308	0.413	0.040	0.173	0.594	0.24
TS	0.509	0.400	0.097	0.010	0.132	0.195	0.24
EL	0.049	0.069	0.053	0.530	0.526	0.049	0.24
PA	0.078	0.272	0.142	0.186	0.122	0.049	0.14

Overall weight for each rainfall is computed as follows:
For each rainfall station (at each row), multiply each period weight (i.e. calibration/validation) by the weight of each rainfall station with respect to the low level criteria, and sum up the result of the two periods.

For example: Weight SH = 0.5[0.111* 0.49 + 0.195*0.32 + 0.295*0.19] + 0.5[0.49*0.144 + 0.32*0.048 + 0.19*0.111] = 0.14 = 14 %

Analytic Hierarchy Process (AHP) in selecting Artificial Neural Networks (ANN) for ungaged streamflow Prediction

Masengo Ilunga
Department of Civil Engineering & Chemical Engineering,
University of South Africa,
Pretoria, South Africa.
E-mail: ilungm@unisa.ac.za

ABSTRACT

The current paper illustrates the versatility of Analytic Hierarchy Process (AHP) in ranking/selecting Artificial Neural Network (ANN) techniques. ANNs (i.e. Counterpropagation network-CPN and the generalized regression neural network-GRNN) have been obtained from the literature where they have been used to forecast streamflow at an ungaged basin (Winooski River Basin situated in the northwestern Vermont, USA). AHP methodology is illustrated through daily and hourly streamflow prediction at Doge River, which is primarily an unregulated river. In the AHP formulation, statistical metrics or evaluation criteria; i.e. Root Mean Square Error of Predictions (RMSE), Coefficient of Determination (R^2) and the Nash-Sutcliffe (E) are used as low level criteria while daily and hourly time steps are used as high level criteria. Through pairwise comparisons, the judgment matrix obtained from these metrics led to a consistent judgment. Results showed that the overall preferences for CPN and GRNN were 69 % and 31 % respectively for Doge River in the Winooski River Basin. This can guide users in water applications/projects on preference for the technique/model to be used further for ungaged sites.

Keywords: Analytic hierarchy process, ungaged basin, streamflow prediction

1. INTRODUCTION

There is no doubt that streamflow data are the main inputs for water projects such as hydraulic structures and many studies in hydrology and water resources. Some time these data for specific basins where water projects should be carried out are inexistent or are very limited due to the absence of gauges or mal-functioning of gauges. This problem is more common in developing countries than developing countries. The literature shows there is a need for streamflow estimation for ungaged basins for water resource development [5], [6], [7]. However, the literature on ungauged streamflow prediction problems using ANNs is very sparse, e.g. [1], [2]. Nonetheless the current study is the first attempt to apply AHP methodology to this type of problems. Forecasting methods such as ANNs are first trained on gauged sites then used to forecast ungauged streamflow [1]. It is common to compare prediction models or techniques for ungauged streamflow using statistical metrics; however it is almost inexistent from previous studies to estimate preferences that the water resource manager/decision-maker/water user will have to make among these specific models. As outlined by [2], model comparison is usually done by assessing the magnitude of the different statistical metrics. A high number of model criteria (statistic metrics) can make this comparison complicated. The situation can be exacerbated with the high number of models used. AHP as a multi-criteria decision making tool enables users to make preferences through a consistent judgment. In this study, to demonstrate the versatility of AHP, its formulation and implementation are inspired from a previous study in the literature [1], where CPN and GRNN have been used as best forecasting streamflow techniques at gauged Dog River, in the USA. Then the training capabilities of these models were used to predict flows at the ungauged Winnosky River at Monpellier site [1]. This study is primarily limited to the ranking of CPN and GRNN during streamflow prediction at Dodge River before they are even chosen as further candidate predictive tools for different ungauged sites; e.g. at Winnosky River. No explicit ranking for performance comparison between CPN and GRNN was conducted in the previous study [1]. In what follows "model" and "technique" may have the same meaning.

2. AHP AND STREAMFLOW PREDICTION IN UNGAGE BASINS

Despite the popularity of AHP to water management related problems [8], its application to streamflow prediction remains very sparse [2]. Currently there is no literature specifically on AHP application to ungaged streamflow prediction relating to ANN techniques.

Decisions makers can use AHP methodology in the selection process for ANN related problem, e.g. [2]. AHP methodology comprises mainly 3 levels:

-The goal is the broader objective to be achieved

-The criteria (e.g. High level criteria and low level criteria) enable alternative to be assessed to reach the goal

-The alternatives are options among which the decision-maker should decide.

Pairwise comparisons based on a 1 to 9 scale characterize essentially AHP methodology. The scale is defined as follows: 1-equal importance between elements; 3: moderate importance; 5: strong importance; 9: extreme importance. Intermediate values 2, 4, 6 and 8 are also used during AHP process. For reference, AHP methodology has been explained extensively in the lliterature, e.g. [9], [10], [11].

3. AHP AND PREDICTION MODELS FOR UNGAGED STREAMFLOW

Data availability

Performance of CPN and GRNN on hourly and daily streamflow data Dog River used in this study have been obtained from the literature [1]. This information (summer flow prediction from 2004-2006) as depicted in Table 1 constitutes the basis for AHP formulation. In this table, the different metrics are shown for different time-steps; i.e. hourly and daily.

Table 1. Performance of CPN and GPNN summer flow predictions at the Dog River from 2004-2006, data extracted from [1]

Statistical metrics	CPN		GPNN	
	Daily	Hourly	Daily	Hourly
R^2	0.29	0.5	0.29	0.45
E	0.16	0.28	0.02	0.28
RMSE	5.5	5.2	5.9	5.5

AHP formulation and implementaion for rainfall station rainking

From Table 1, the formulation of AHP can be presented as follows:

- Goal: ranking/selecting ANN models: CPN and GRNN.
- High level criteria: Daily and hourly time steps
- Low level criteria: statistical metrics: R^2, E and RMSE
- Alternatives: CPN and GRNN models

AHP implementation is done in the following.

Pairwise comparsion of low level criteria

RMSE; E and R^2 are criteria which were used to construct the judgment matrix for AHP. The RMSE was considered to have more importance that the rest of criteria as far as a direct measure of the accuracy of predicted streamflow values is concerned [2]. Hence for the purpose of the accuracy of predicted streamflow, the author considered subjectively that RMSE can be moderately important than RMSE and RMSE is between equal important and moderately important than R^2. E was considered to be moderately important than R^2. Unlike the other 2 metrics, the coefficient of determination is a good measure for linearity [2] and comes in last position in terms of pairwise comparisons. These pairwise comparisons could be acceptable since the judgment matrix (Table 2) led to an acceptable consistent ratio.

Table 2 Pairwise comparison of low level criteria (R^2, E, RMSE)

	R^2	E	RMSE
R^2	1	0.5	0.33
E	2	1	0.5
RMSE	3	2	1

Pairwise comparison of high level criteria

Since the accuracy predictive is a function of time scale with hourly prediction to be more accurate than daily step [1], the user or decision maker will have more preference on predicted daily data. Hence the high level criteria, i.e. daily and hourly time steps are not considered to have equal importance or preference. This is shown in Table 3 where hourly time step has a value of 4 over daily time. Conversely daily time step has ¼ preference over hourly time step.

Table 3. Pairwise comparison of high level criteria

	Daily	Hourly
Daily	1	0.25
Hourly	4	1

Alternative pairwise comparisons

The two ANN techniques, i.e. CPN and GRNN were subjected to pairwise comparisons using statistical metrics as criteria. Pairwise comparisons were carried out among the different rainfall stations with respect to statistical indicators and are summarized in Tables 4a, 4b and 4 c for the daily period. From Table 1, for instance CPN and GR have the same level of preference when using criterion R^2; hence a value of 1 (i.e. equal importance will be given) as shown in Table 4a. Similarly, results can be derived when using criteria E and RMSE and shown in Tables 4b and 4c. Similar tables were also obtained for hourly period; however they are not displayed here.

Table 4a. Pairwise comparison of streamflow prediction ANNs with respect to R^2(daily time step)

	CPN	GRNN
CPN	1	1
GRNN	1	1
	2	2

Table 4b. Pairwise comparison of streamflow prediction ANNs with respect to E (daily time step)

	GPN	GRNN
GPN	1	7
GRNN	0.142	1

Table 4c. Pairwise comparison of streamflow prediction ANNs with respect to RMSE (daily time step)

	GPN	GRNN
GPN	1	3
GRNN	0.333	1

4. RESULTS AND DISCUSSION

Table 5 showed in the values of low level criteria (i.e. statistical criteria) that have been derived from Table 2. For pairwise comparisons among these criteria, RMSE has the highest weight

(54%), followed by E (30 %), then by RMSE (16%) as depicted in the last column of Table 5. This suggests that the decision maker will have more preference for RMSE than the other two criteria. These results have been influenced on the subjective considerations mentioned early. Nonetheless, the consistency ratio (CR = 0.5 %) computed was found to be less than 1. Hence the judgment for the pairwise comparisons was considered to be consistent with respect to the low level criteria. In other words, the judgment is valid.

Table 5. Low level criteria weights

	R^2	E	RMSE	Weights
R^2	0.17	0.14	0.18	0.16
E	0.33	0.29	0.27	0.30
RMSE	0.50	0.57	0.55	0.54

For daily time scale, the weights of the ANN techniques with respect to the statistical metrics (i.e. low level criteria) were computed as shown in Tables 6a, 6b and 6c. Similarly weights of ANNs for hourly time step were computed and presented in Tables 7a, 7b and 7c of Appendix 1.

Table 6a. Weights of ANNs with respect to R^2 (daily time step)

	GPN	GRNN	Weights
GPN	0.5	0.5	0.5
GRNN	0.5	0.5	0.5
	1	1	1

The two techniques CPN and GRNN have the same weights (preferences) when R^2 is the only criterion used. In other words, the decision-maker/user will attribute the same importance to these models for the purpose of ungauged streamflow prediction, if it were to use R^2 as the only criterion.

Table 6b. Weights of ANNs with respect to E (daily time step)

	CPN	GRNN	Average
CPN	0.88	0.88	0.88
GRNN	0.12	0.13	0.12

Unlike in the previous case, the weights of the two techniques, i.e. CPN and GRNN are 88 % and 12 % respectively when E is used as criterion. Hence the decision-maker/user will make his choice first on CPN technique for streamflow prediction, if E is used as the only criterion.

Table 6c. Weights of ANNs with respect to RMSE (daily time step)

	CPN	GRNN	Weights
CPN	0.75	0.75	0.75
GRNN	0.25	0.25	0.25

When RMSE is the only criterion used, the decision maker will give more preference to CPN (75 %) than GRNN (25%). This will depend on the user's applications.

For hourly time scale (Appendix I), CPN displayed higher weight (75 %) than GRNN (25%) when pairwise comparisons among ANNs are carried using R^2 and RMSE (as displayed in Tables 7a and 7c). As far as streamflow prediction at ungaged sites is concerned, the decision maker will have more preference to use CPN technique than GRNN when using R^2 and EMSE as criteria for hourly time step. However ANN techniques have the same weights (50 %) when E is used as criterion for pairwise comparisons among ANNs (see Table 7b). It should be noted that the choice for ANN technique is not necessarily the same similar for both time steps when considering a specific criterion.

The overall weights in the selection process for ungauged prediction techniques were 69 % and 31 % for CPN and GRNN respectively. These results are shown in Appendix 2, Table 8. It could be said that the water manager (decision maker, modeler or user) will have more preference on the first alternative, i.e. CPN than the second alternative, i.e. GRNN. This shows that CPN could be the most preferred candidate model as far as the process of predicting streamflow at the ungaged sites is concerned. These results could support further the relative greater accuracy of CPN over GRNN for prediction of streamflow in ungaged sites [1]. It is interesting to have shown; through a consistent judgment in using AHP that CPN is the most promising candidate technique before even it is applied to ungauged sites.

This ranking is only valid to the application of ANNs (i.e. CPNN and GRNN) to ungauged streamflow prediction, specifically for Winooski River Basin in USA. The results are limited to the set of statistical criteria as well as daily and hourly step. More criteria, ANN techniques, other times steps (seasonal, annual, etc) could have influenced the decision-making process for ungauged streamflow prediction. The decision could have been different for ungaged basins other than Winooski River Basin.

5. CONCLUSIONS

This study has demonstrated the versatile capabilities of AHP, by applying to the selection of models to be used further for streamflow prediction at ungauged basins. The ANN methodology was limited to a relatively simple case of two ANN techniques, i.e. CPN and GRNN. Through a consistent judgment, the overall preferences on models were 69 % and 21 % respectively for the purpose of using these models for ungauged streamflow prediction specifically at the Winnoski River at Montpellier site. This could guide decision-maker in the selection process for the purpose of streamflow prediction at ungauged basins. The current study can be extended by applying AHP to more than two ANN models as well as more statistical metrics. AHP as implemented in this study should be applied to more ungaged sites.

ACKNOWLEGMENTS

The author acknowledges the use of data extracted from Besaw et al (2010) publication for formulating and implementing AHP technique.

6. REFERENCES

[1] L. E. Besaw, D. M. Rizzo, P.R Bieman, W.R. Hackett, "Advances in ungauged streamflow prediction using artificial neural networks", **Journal; of Hydrology**, Issue 386, 2010, pp. 27-37

[2] E. Onyari, F. Ilunga, "Application of MLP neural network and M5P model tree in predicting streamflow: A case study of Luvuvhu catchment, South Africa", **International Conference on Information and Multimedia Technology (ICMT 2010),** Hong Kong, China, p. V3-156-160, pp. V3-156-160

[3] Odiyo, J. O, Nkuna, T.R, "Filling of missing rainfall data in Luvhuvhu River Catchment using artificial neural networks", **Physics and Chemistry of the earth**, Vol. 36, issues 14-15, 2011, pp. 711-1208.

[4] M. Khalil, U.S. Panu, W. C. Lennox, "Group and neural networks based streamflow data infilling procedures", **Journal of Hydrology**, Vol. 241, 2001, pp.153-176.

[5] J. Samuel, P. Coulibaly, & R. Metcalfe, "Estimation of continuous streamflow in Ontario Ungauged Basins: Comparison of regionalisation methods", **Journal of Hydrologic Engineering**, ASCE, Vol.16, No. 5, May 2011, pp. 447-459.

[6] Y. He, A. Bardossy, E Zehe, "A review of regionalisation for continuous streamflow simulation", **Hydrology and Earth Systems Science**, Issue 15, 2011, pp. 3539-3559.

[7] M. D. Prinzioo, A. Castellarin, E. Toth, "Data driven catchment classification: application to the pub problem', **Hydrology and Earth Systems Science**, Issue 15, 2011, pp. 1921-1935.

[8] S. Biswas, H. Vacik, M.E. Swason, S.M. Sirajul Haque, "Evaluating integrated watershed management using multiple criteria analysis-a case study at Chittagong Hill Tracts in Bangladesh", **Environmental Monitoring Assessment**, Vol. 184, 2012, pp. 2741-2761

[9] C.W. Chang, C.R. Wu, C.T. Lin, C.H. Chen, "An application of AHP and sensitivity analysis for selecting the best slicing machine", **Computers and Industrial Engineering**, Vol. 52, 2007, pp. 296-307.

[10] R. Whitaker, "Validation examples of the Analytical Hierarchical Process and Analytical Network Process", **Mathematical and Computer modelling**, Vol., 46, 2007, pp. 840-859.

[11] Saaty, T.L., How to Make a Decision, **The Analytic Hierarchy Process**, *Interfaces*, Vol. 24, No 6, 1994, 19-43

7. APPENDICES

Appendix 1: Determination of ANN weights for hourly time step

Table 7a. Weights of ANNs with respect to R^2 (hourly time step)

	CPN	GRNN	Weights
CPN	0.75	0.75	0.75
GRNN	0.25	0.25	0.25

Table 7b. Weights of ANNs with respect to E (hourly time step)

	CPN	GRNN	Weights
CPN	0.5	0.5	0.5
GRNN	0.5	0.5	0.5

Table 7c. Weights of ANNs with respect to RMSE (hourly time step)

	CPN	GRNN	Weights
CPN	0.75	0.75	0.75
CRNN	0.25	0.25	0.25

Appendix 2: Calculation of overall weights for ANNs

Table 8. Overall weights of alternatives (ANNs)

ANN technique	Daily [0.2]			Hourly [0.8]			Overall weight
	R^2[0.16]	E[0.30]	RMSE [0.54]	R^2[0.16]	E[0.30]	RMSE [0.54]	
CPN	0.50	0.87	0.75	0.75	0.50	0.75	0.69
GRNN	0.50	0.13	0.25	0.25	0.50	0.75	0.31

Overall weight for each rainfall is computed as follows:
For each ANN technique (row), the overall weight is obtained by multiplying each time step weight (i.e. daily/hourly) with the weight of the specific ANN with respect to each statistical metric weight and adding the results of the two time steps.

Featuring and Scoring Answers Extracted from Web Pages for How-to Question-Answering

Kyohei Ishikawa
Division of Industrial Administration
Graduate School of Science and Technology,
Tokyo University of Science,
2641 Yamazaki, Noda, Chiba, 278-8510, Japan
j7412604@ed.tus.ac.jp

and

Katsutoshi Kanamori
Department of Industrial Administration
Faculty of Science and Technology,
Tokyo University of Science,
2641 Yamazaki, Noda, Chiba, 278-8510, Japan
katsu@rs.tus.ac.jp

and

Hayato Ohwada
Department of Industrial Administration
Faculty of Science and Technology,
Tokyo University of Science,
2641 Yamazaki, Noda, Chiba, 278-8510, Japan
ohwada@rs.tus.ac.jp

ABSTRACT

Recently, question-answering techniques have attracted attention. Non-factoid question answering has been widely studied in recent years, but it is still a difficult topic. In this study, we describe how to extract an answer that serves as a correct answer to a how-to question about actions to be taken on the Web. The distinguishing features of this study are the extraction of sentences using the importance of words and the feature representation of the answer. We propose a method to extract an answer that contains two or more sentences. The results of the experiment indicated a Mean Reciprocal Rank (MRR) of 0.412, an average recall of 68.7%, and an average precision of 71.9%.

Keywords: How-to question answering, Web documents, Extraction, Feature representation, Q&A community

1. INTRODUCTION

Due to the rapid spread of the Internet, a vast amount of information is available. For daily questions, the opportunity to find information on the Web using a search engine is increasing. However, to use existing search engines, it is necessary to adequately represent a question in the search query. One problem is that we must look for answer phrases and sentences on the pages that are found, since search engines present some Web page recommendations but do not present the answer itself. In order to solve such a problem, question-answering systems to extract answers and present them have been studied in natural language. In the current study, the question answering task is divided into two types: factoid and non-factoid. The former involves questions that ask for something specific (e.g., a name or a quantity), and the latter asks for more complex information, such as a reason or a method. Non-factoid question answering has been widely studied in recent years, but it is a difficult topic. When searching on the Web, it usually takes more time find answers to non-factoid questions than it does to find answers to factoid questions.

This study seeks to extract correct answers to questions without leakage from sentences on the Web, focusing on non-factoid how-to questions. In this study, the how-to question is defined as a question that asks for a description of meanings. We propose a method for extracting question-answering sentences and evaluate its effectiveness.

2. RELATED WORK

This section describes some related works on non-factoid question answering, including how-to question answering.

Soricut et al. [1] proposed a method that does not depend on question type, using a set that consists of questions and answers on a Q&A site as a parallel corpus. Using this approach, they calculated the probability that the answer is rewritten in a question, set the answer range to the average number of sentences of answers in a corpus, and extracted answers.

Mizuno et al. [2] also collected question and answer pairs from a set that consists of questions and answers on a Q&A site and assigned an answer type to each answer. They applied SVM learning collaboration of a question type and an answer type, and judged whether each answer had a corresponding answer to each question type without classifying question types.

Mihara et al. [3] used action expression (noun + particle + verb) to extract answers to how-to questions. They proposed a question-answering system that considers the portion including a suitable action expression as an answer. In their answer extraction, they extracted paragraphs of a fixed length as answers using tag information and scored some paragraphs. Finally, the system presents a high-scoring paragraph.

Since these methods set the answer range beforehand, the system cannot dynamically change the range of an answer candidate according to a question.

An answer to a non-factoid question differs from an answer to a factoid question, which is a comparatively short answer (e.g., a noun or a noun phrase). The answer may have a high possibility, the answer range is described by two or more sentences and the answer range may change depending on the question. Therefore, it is not desirable to fix the number of answer sentences beforehand. In this paper, we propose a method of determining the answer range according to the given question.

3. PROPOSED METHOD

In this paper, we propose a method of extracting answers focusing on the number of occurrences of words that are contained in Web documents and the feature representation of the answers to implement a how-to question-answering system. Moreover, we specify answer sentence candidates while considering the form of the sentence that is suitable as the answer to a how-to question.

The appropriateness of answers can be judged by the match of question type and answer type, and the relevance of the question contents to the answer contents [4] [5]. With our method, we compute the relevance of the question contents and each sentence's contents based on the frequency of the appearance of words. We use a corpus as the set that consists of questions and answers in a Q&A site to estimate the feature expression of the answers to how-to questions. Figure 1 depicts an outline of the proposed method.

Question analysis and importance of words

This chapter describes the method of generating queries from questions in a Web search. We obtain content words from the input question and make the keyword set K from those words. Content words are nouns, verbs, and adjectives. First, we extract nouns contained in K . If we can construct compound nouns from those nouns, we then make compound nouns

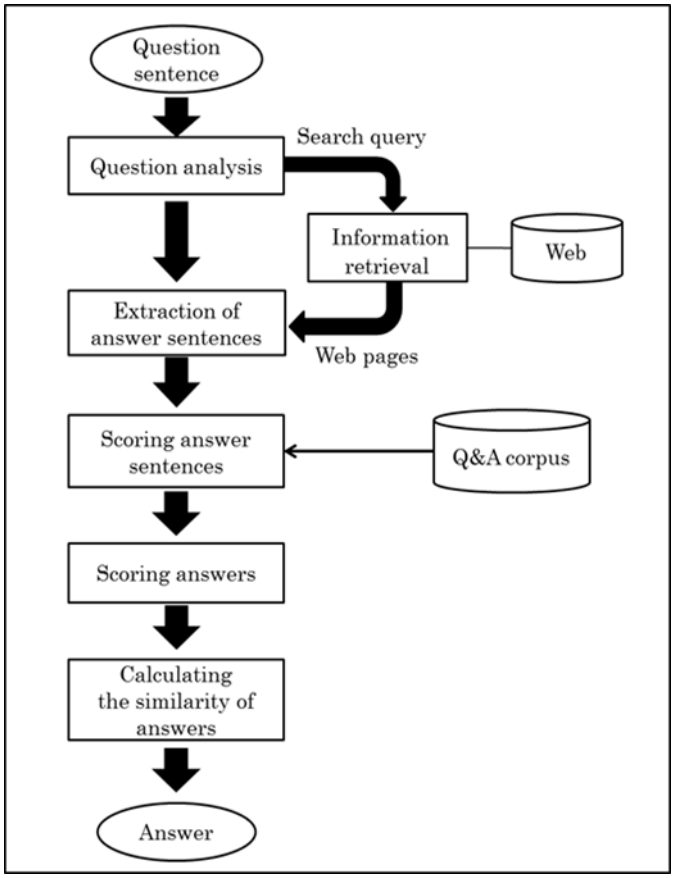


Fig. 1. Flowchart of the proposed method

and construct a set K_c from the nouns and compound nouns. We then construct a set K_a from verbs and adjectives. If the question sentence contains adverbs, we construct a set K_y from those words.

We prepare the three sets K , $K_c \cup K_a$, and $K_c \cup K_a \cup K_y$; combine the words in each set; and perform AND search using a search engine. We search in order of,$K_c \cup K_a \cup K_y$, $K_c \cup K_a$, and K, but we limit the search if the search query is the same as a query in before search. We calculate the importance of each word from the Web document obtained by these searches. The importance of words is defined by formula (1). In formula (1), n_i is the total number of documents obtained when query q_i is used for the search, d is the number of documents containing the word w_{ij}, and $freq(i,j)$ is the number of appearances of the word in all documents. In this study, we use the reciprocal because we want words that are used in many Web documents to be considered important words. Using the reciprocal raises the importance of words that appear in many Web documents.

$$I(w_{ij}) = \frac{freq(i,j)}{log\frac{|n_i|}{\{d: d \ni w_{ij}\}} + 1} \quad (1)$$

Feature representation

We can guess the feature of a how-to question and its answers to some extent. Table 1 provides a simple example.

Table 1. Example of question style and answer style in how-to question answering.

Question style	Answer style
What should I do to ～	First, you should ～
Please tell me how to A	In order to A, you need to～

In order to estimate features of answers to how-to questions, we use as a corpus the set that consists of questions and answers on a Q&A site. In this set, a question and an answer to the question become one pair.

In this study, we use a question-answer set of the Yahoo! Chiebukuro,[1] a Q&A community service, as a Q&A corpus. The questions and answers in this corpus were accumulated from April 2004 to October 2005. Although there may be several answers to a question, we use only the best answer the URL is not listed, because we assume that the answers on which the URL is written has a low possibility of answering the questioner directly.

We extract the H number of how-to questions that meet the style of the two questions in Table 1 from the corpus. We then extract feature expressions from answer sentences corresponding to the collected questions. The feature expression is defined as the bigram with a high χ^2-value between the answer sentence set A corresponding to the collected questions and the remaining answer sentence set $\overline{A}$ in the corpus. The bigram b is calculated using formula (2). In formula (2), B is the answer sentence set containing b, and $\overline{B}$ is the answer sentence set that does not contain b. We use the top 200 feature expressions with a high χ^2-value for answer extraction.

$$\chi^2(b,A)=\frac{n\cdot(|A\cap B|\cdot|\overline{A}\cap\overline{B}|-|\overline{A}\cap B|\cdot|A\cap\overline{B}|)^2}{|A|\cdot|\overline{A}|\cdot|B|\cdot|\overline{B}|} \quad (2)$$

Scoring and answer extraction

The score of each sentence S_i is defined by formula (3) using formulas (1) and (2). In this formula, n is the number of words, m is the number of feature representations in sentence S_i, $L(S_i)$ is the length of sentence $S_{i,}$, and α is a parameter.

$$Score(S_i)=\frac{\{\sum_{j=1}^{n}T(w_{ij})\}^{\alpha}\cdot\{\sum_{k=1}^{m}\sqrt{\chi^2(b_{ik})}\}^{1-\alpha}}{\log(1+L(S_i))} \quad (3)$$

If a high-scoring sentence appears continuously, we assume that the range which those sentences followed are suitable as an answer. We then extract the top 30 sentences whose scores are the local maximum. These sentences are key sentences. We compare the scores of sentences before and after the key sentences. If the scores of sentences before and after the key sentences are higher than half of the local maximum, we extract these sentences as answer candidates with the key sentences. If the scores of sentences before and after the key sentences are lower than half of those scores, we regard only the key sentences as answer candidates. Figure 2 presents an example of answer extraction. An answer candidate's score is the total of each score of sentences contained in an answer candidate. In formula (4), R is an answer candidate, and p is the number of sentences in the answer candidate.

sentence	score
sentenceA	57
sentenceB	56
sentenceC	88
sentenceD(key sentence)	158
sentenceE	96
sentenceF	84
sentenceG	32

⇩

Answer candidate

sentenceC
sentenceD(key sentence)
sentenceE
sentenceF

Fig. 2. Example of answer extraction.

$$Total-Score(R_i)=\sum_{t=1}^{p}Score(S_{it}) \quad (4)$$

Scoring by question and answer similarity

If the first sentence in an answer describes a solution in the following sentences, we consider the answer as correct (Fig. 3).

If the first sentence is similar to the question sentence, we assume that the answer is likely to be correct. The similarity of a first sentence and a question sentence is calculated based on the co-occurrence frequency of words. We define the set of words extracted from the first sentence as C. The co-occurrence score of C for the content words of the question sentence is defined as

$$P_i=\frac{Count_{max}(C)}{Count(C)} \quad (5)$$

Here, $Count(C)$ is the number of words of C, and $Count_{max}(word)$ is the maximum number of co-occurrences of the content words of the question and the words of C. A final score is given by formula (6).

$$L-Score(R_i)=Total-Score(R_i)\times exp(log(P_i)) \quad (6)$$

Calculating the similarity of answers

Two or more answers with similar content should not be presented to a user. Therefore, we delete an answer that has content similar to that of a high-scoring answer. The similarity of the contents of answers was calculated using the cosine similarity indicated in the formula (7). The feature of a vector is the importance of words in 30 answer candidates. We determine the importance of each word using the tf-idf method in 30 extracted answer candidates.

Question: Please tell me how to stop a nosebleed.

Answer:
The following method is a how to stop a nosebleed.
To press the bottom of the nose with a finger is effective for stopping a nosebleed earliest. Knob to the bottom of the nose with your thumb and forefinger, press 5 to 10 minutes.

Fig. 3. Example of an answer with a first sentence that is similar to the question.

[1] (http://chiebukuro.yahoo.co.jp/)

$$cos(\vec{v},\vec{u}\,) = \frac{\vec{v}\cdot\vec{u}}{|\vec{v}||\vec{u}|} = \frac{\sum_{i=1}^{n} v_i \cdot u_i}{\sqrt{\sum_{i=1}^{n}(v_i)^2} \times \sqrt{\sum_{i=1}^{n}(u_i)^2}} \quad (7)$$

Consideration of part of speech

We consider the following factors when extracting an answer.

1) Some words (auxiliaries; particles; verbs "be," "do," and "become"; and the nouns "answer" and "question") appear so often that we do not consider them valid in answer extraction and their importance is not calculated. In addition, the importance of unknown words and signs is not calculated.
2) A sentence that does not contain a verb is not extracted as an answer, since a how-to question asks for a description of meanings.
3) The part of speech of the sentence ending is considered. As a result of investigating the part of speech of the sentence ending a correct answer to a how-to question, we determined that the part of speech of many sentence endings is a verb, a particle, or an auxiliary verb. Therefore, we extracted sentences whose endings matched these parts of speech.

4. EXPERIMENT

We conducted an experiment to evaluate the effectiveness of the proposed method.

Experiment method

We obtained sentences from Web pages using existing search engines, such as Google. Since Google regards a page that is linked to many other pages as high priority, we can incorporate this measure with partial reliability. Each question sentence was turned into a query using the proposed method. We extracted answers from sentences on the top 50 Web pages written in Japanese per query. We set *H* to 500, where *H* is the number of how-to questions extracted from the corpus.

In this experiment, we used four methods to identify effective factors in extracting answers. We change parameter α in formula (3) to compare the result when the feature expression is considered and the result when the feature expression is not considered. Method 1 sets α to 0.5. Method 2 sets α to 1. Method 3 sets α to 0.5, but without scoring by similarity of question and answer as described. Method 4 sets α to 0.5, but without deleting an answer that is similar to the content of the high-scoring answer as described.

Finally, the top 10 high-scoring answers are extracted.
0
Evaluation method

In this experiment, "a correct answer" is defined as an answer that has been verified to resolve the question. Correct answers were evaluated by hand, without considering whether the were actually effective. We used the Mean Reciprocal Rank (MRR) indicated in formula (8) to evaluate this proposed method. Here, *N* is the number of questions. In this experiment, we use 30 how-to questions.

$$\text{MRR} = \frac{1}{N}\sum_{k=1}^{N}\frac{1}{rank(k)} \quad (8)$$

Table 2. Result of each method.

	MRR	recall	precision	F-score
Method1	0.412	0.687	0.719	0.703
Method2	0.288	0.468	0.652	0.545
Method3	0.365	0.534	0.647	0.585
Method4	0.329	0.664	0.652	0.658

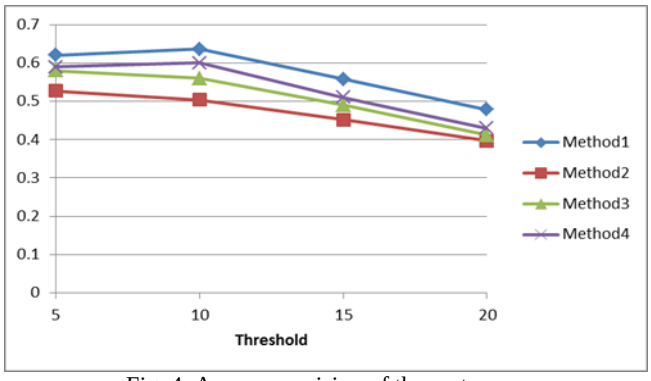


Fig. 4. Answer precision of the system.

In addition, we evaluate whether each sentence in an answer is appropriate. We use the recall, precision, and F-score given by formulas (9), (10), and (11) for this evaluation.

$$recall = \frac{Num\ of\ correct\ sentences\ extracted}{Total\ Num\ of\ correct\ sentences} \quad (9)$$

$$precision = \frac{Num\ of\ correct\ sentence\ extracted}{Num\ of\ sentences\ extracted} \quad (10)$$

$$F-score = \frac{2\times\ precision\times\ recall}{precision\ +\ recall} \quad (11)$$

Experiment result

Table 2 presents each experiment result. Precision, recall, and F-score are the averages for all questions. These values were calculated from the top 10 answers.

Furthermore, we provided a threshold for the number of answers presented by the system in order to determine whether the system is able to present the correct answer. We varied the threshold and from 5 to 20 and calculated the answer precision of each method. Answer precision is the average for all questions. This result is presented in Fig. 4.

5. DISCUSSION

The experiment results indicate that method 1 has the highest MRR (0.412) and method 2 has the lowest MRR (0.288). We thus conclude that scoring by feature representation is effective. Moreover, since methods 3 and 4 have a higher MRR than method 2, we conclude that scoring by similarity of the question and answer, and deletion of answers similar to the high-scoring answer are effective. Method 1 has the highest F-score (0.703). For method 2, recall is low and precision is high, possibly because of the small number of extracted answer sentences in many cases.

Figure 4 indicates that when thresholds are 5 and 10, answer precision is high for each method, indicating that scoring answers was somewhat successful. Moreover, for method 4, answer precision was maximum when the threshold was 10; for method 3, it was maximum when the threshold was 5. This is possibly due to the fact that the rank of correct answers goes up and these answers are included in the top 5 by deleting answers similar to the high-scoring answers in many cases.

In addition, for some questions the correct answer may not have a high rank because sentences are scored with importance based on how frequently words appear.
Therefore, it is necessary to re-examine the scoring method and the answer extraction method.

6. CONCLUSION

In this study, we proposed an answer extraction method focusing on non-factoid how-to questions. The experiment results confirmed that the feature representation of answers is effective in answer extraction. Future work will involve experiments using large-scale data.

We express our thanks to Yahoo! Japan NII for providing us with Yahoo! Chiebukuro data.

7. REFERENCES

[1] Radu Soricut and Eric Brill. Automatic question answering using the web: Beyond the factoid. **Journal of Information Retrieval – Special Issue on Web Information Retrieval**, Vol.9, pp.191-206, November 2006.
[2]Ryota Mizuno, Tomoyoshi Akiba, “Analysis of the real world question for the question-answering for arbitrary answers, and examination of a answer type judgment method”, **13th Annual Meeting of Proceedings of the Association for Natural Language Processing**, pp.1002-1005.
[3] Eri Mihara, Atsushi Fujii, Tetsuya Ishikawa, “Help desk-oriented question-answering focus on action representation”, 11th Annual Meeting of Proceedings of the Association for Natural Language Processing, pp.1096-1099(2005).
[4] Kyoung-Soo Han, Young-In Song and Hae-Chang Rim, “Probabilistic model for definitional question answering”, **In SIGIR**, pp.212-219, 2006.
[5] Mitsuru Sato, Madoka Ishioroshi, Tatsunori Mori, “Question answering system that can answer descriptive using Web documents as information sources”, **14th Annual Meeting of Proceedings of the Association for Natural Language Processing**, pp.1009-1012

Proposal for a Similar Question Search System on a Q&A Site

Akinori Kanda, Katsutoshi Kanamori, and Hayato Ohwada

Division of Industrial Administration
Graduate School of Science and Technology,
Tokyo University of Science,
2641 Yamazaki, Noda, Chiba, 278-8510, Japan
j7412607@ed.noda.tus.ac.jp, katsu@rs.tus.ac.jp and ohwada@rs.tus.ac.jp

ABSTRACT

There is a service to help Internet users get answers to specific questions when they visit a Q&A site. A Q&A site is very useful for the Internet user, but posted questions are often not answered immediately. The delay in answering happens because in most cases, an other site user answers the question manually. In this paper, we propose a system that can present a question that is similar to a question posted by a user. An advantage of this system is that a user can refer to an answer to a similar question. This research measures the similarity of a candidate question based on word and dependency parsing. In an experiment, we examined the effectiveness of the proposed system for questions actually posted to the Q&A site. The result indicates that the system can show the questioner the answer to a similar question. However, the system still has a number of aspects that should be improved.
Keywords: Q&A site, Information retrieval, NLP, Tf-idf, Dependency parsing.

1. INTRODUCTION

Recently, a service called a Q&A site has emerged as an Internet service. In this service, a user(asker) posts a question on a Q&A site and other users post the answer. Major Q&A sites include Baidu Zhidao,[1] OKWave,[2] Quora,[3] and Yahoo! Chiebukuro[4](Japanese Yahoo Answers[5]). Although a search engine displays its results immediately for a given keyword, a Q&A site cannot display the answer immediately.
There is a delay in answering because, in most cases, another site user answers the question manually. Moreover, a posted answer may be not useful for the asker, and an asker who posts a survey type question such as "Which do you like sweet food or spicy food?" might get many opinions as the answer.

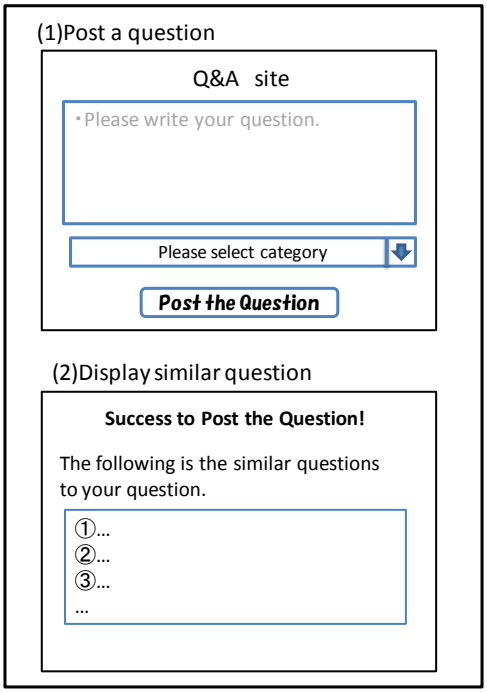


Fig. 1 System Image

In this paper, we propose a system that can present a question that is similar to a question posted by a user. Figure 1 illustrates the system. Screen (1) used to post a question. As seen in (1), a typical Q&A site has a space to enter a question, and a section for choosing a question category. The question category indicates to what category the question belongs. For example, a question about cooking belongs to "cooking" and a question about soccer belongs to "sports". Screen (2) displays similar questions to the user. All similar questions will be displayed on screen (2). It should be noted that the system executes two tasks, posting a question and searching for similar questions, at the same time. In this case, the user does not need to search for similar questions by himself, and can see such questions immediately.

In order to create such a system, the assumptions that follow were considered in this research.

- The system is only given a sentence (a keyword is not given).
  Information retrieval generally uses a search by keywords. When we use the Internet to search for things, we usually use a search engine (such as Google or Yahoo!) by entering some keywords. However, a sentence in natural language is entered in this system. Therefore, a method

[1] http://zhidao.baidu.com/
[2] http://okwave.jp/
[3] https://www.quora.com/
[4] http://chiebukuro.yahoo.co.jp/
[5] http://answers.yahoo.com/

that does not search by keywords must be used, or keywords must be selected from the sentence.

- It is possible to do parsing.
  The system is given a sentence, so parsing can be used. In this research, the dependency relations among words investigated using a dependency analysis.

We investigated what method is the most effective as a system, considering the above matters. This paper is organized as follows. In the next section, we review related work. Section 3 presents the details of the proposed system. We give our detailed experiment results in the next section, along with discussion. Finally, the conclusion of the paper will be presented, along with some directions for future work.

2. RELATED WORK

Research on Q&A sites has been conducted for a variety of purposes. For example, some have studied the prediction of the best answer, the clustering of questions, etc.

In research on the best answer, Kim et al. investigated by what standard the best answer is chosen [1]. In addition, Nishihara et al. suggest a method for judging an answer that is more likely to become the best answer when a question and certain answers were given [2]. Furthermore, Ishikawa et al. did research on what predicts a good-quality answer [3]. It does not depend on the best answer. They judge a good answer based on detail, reason, graciousness, etc.

In the research clustering questions on Q&A site, the classification method changes depending on the purpose. For example, Watanabe et al. classified questions into five types, such as seeking a fact and a reason [4]. This is intended to recommend questions to a user that posts an answer. Moreover, Harper et al. classified questions on a Q&A site [5]. This work involved the standards for being valued as archival. Furthermore, Long et al. classified questions into three types [6]. This was to find a potential answer and question similar to the question a user posted. Tamura et al. classified questions having two or more sentences [7]. This was for developing a question-answering system. In order to classify a text, they extract the most important sentence (called the “core sentence” in the paper) in a text, and the intention of a question is classified using this sentence.

Research has also been done to complement an answer by showing user information related to a posted question from outside a Q&A site. For example, Nie et al. are doing research that adds a picture and image information to a question, in order to give an answer more clearly [8].

We investigated the importance of whether an answer the system presents is appropriate for the user that posted the question. Therefore, our purpose differs from the research introduced in this section.

3. PROPOSED SYSTEM MODEL

The proposed system consists of a calculation of similarity among four methods and the integration of the calculation result. We now explain the calculation method for similarity and the integration method used for the result.

Calculation of similarity

We use four methods to calculate similarity. They are (1) n-gram, (2) the number of appearances of a morpheme, (3) tf-idf , and (4) dependency parsing.

(1) n-gram

N-gram is a method of separating the unit that specified the text and counting its frequency of appearance. If the value of n is 1, it is a "uni-gram". If n is 2,it is a "bi-gram". If n is 3, it is a "tri-gram." For example, the when "I studied at home yesterday." is separated by word unit and bi-gram, resulting in:
[I studied], [studied at], [at home], [home yesterday], [yesterday.], [.]

We separate each question by a character unit. When the above example is separated by a character unit, we get:
[I s],[s t],[t u]...[a y],[y .], [.]

We use bi-grams and tri-grams for calculating similarity.

(2) The number of appearances of a morpheme

A morpheme is the minimum linguistic unit with a meaning. We calculate similarity by this method when a text is separated by a morpheme. The morpheme appearing in each text is compared. Our proposed system covers Japanese, referring to [9] for our Japanese morphological analysis.

(3) tf-idf

Tf-idf is a way of weighting the words in the text. Tf-idf is calculated based on the indexes of tf (Term Frequency) and idf (Inverse Document Frequency).

$$\text{tfidf} = \text{tf} \cdot \text{idf} \quad (1)$$

$$tf_{ij} = \frac{n_{ij}}{\sum_k n_{kj}} \quad (2)$$

$$idf_i = \log \frac{|D|}{\left|\{d: d \ni t_j\}\right|} \quad (3)$$

n is the number of occurrences in question *j* of word *i*, *D* is the total of the question text, and *d* is the number of question texts containing word *i*.

(4) Dependency parsing

A dependency analysis is a method for investigating the dependency relations of clauses.

We calculate the similarity by a dependency analysis using the method below. First, we apply dependency parsing to a question. Next, the clause obtained from this is separated into morphemes. Finally, we investigate the dependency relation between nouns and verbs (basic form) as well as adjectives.
For example, if the question sentence "I looked at the beautiful picture in the art museum yesterday." is given, we can find the following dependency relations.
[I=>look], [yesterday=>look], [beautiful=>picture] etc.

At the risk of repetition, since our system covers Japanese, English dependencies may differ.

When dependency is used, it becomes clear that the meanings of the following two sentences differ.
1) “The woman saw a beautiful bird in the town.”
2) “I saw the beautiful woman in the town.”

There two sentences seem to be alike. However, since 1) is [beautiful =>bird] and 2) is [beautiful =>woman], these can be distinguished and it can be determined that their meanings differ.

All of the methods are calculated using cosine similarity. Cosine similarity is a measure of the similarity between two vectors of an inner product space that measures the cosine of the angle between them. The two vectors in this paper are two question sentences to be compared. The minimum value of cosine similarity is 0(if they are not alike at all) and the maximum value is 1(if they are completely the same.). Given two vectors for attributes A and B, the cosine similarity, cos(θ), is represented using the dot product and magnitude as

$$\cos(\theta) = \frac{A \cdot B}{|A||B|} = \frac{\sum_{i=1}^{n} A_i \cdot B_i}{\sqrt{\sum_{i=1}^{n} (A_i)^2} \times \sqrt{(B_i)^2}} \qquad (4)$$

Table1. Example of a posted question, a similar question, and its answer

Posted Question	"Please tell me how to ask a question on the Q&A site."
Similar Question	"What should I do to ask a question on a Q&A site? Which category should be chosen in order to get a good answer? "
Answer	"First, you enter a question. Next, you choose a category. Finally, you click the button marked [post your question] to post your question. I think that the tips which you can use to good get answer are choosing a category suitable for your question and inputting your question in detail."

Integration method for the result

We integrate the results of the similarity calculation in the preceding section. We present a question that was calculated as similar by each method and has a higher value than the set-up threshold value .This is set up for each method. Moreover, we determine its value from the results of a preliminary experiment.

4. EXPERIMENT

Dataset

In our experiments, data were collected from questions in the Yahoo! Chiebukuro data, which contains 3,116,009 questions posted between April 2004 and April 2009.We chose the questions classified as "Internet", which is one of the categories of Yahoo! Chiebukuro from this data. We then randomly selected 15,000 data points and used them as a data set.

Preliminary experiment

The preliminary experiment was for determining the threshold, as mentioned in the discussion of integration method for the result. First, we randomly chose ten questions from the data set . Next, we calculated the similarity by applying each method to each question. Finally, we evaluated them manually. A valuation method is used to determine the appropriateness of a question. We define the question presented to the system the question posted by the user – as Q_p, the question that was judged by the system as being similar to Q_p is Q_s, and the answer for Q_s is A_s. We then evaluate whether A_s is an appropriate answer to Q_p. (See the example in Table 1.)

We determine the threshold based on the following standards. This is the average value of similarity. We list the threshold for each method in Table 2.

Experimental result

We chose ten questions from a data set at random and calculated the similarity using each method. We define a question whose value exceeds in the threshold determined for the preceding section as a similar question. Two evaluators are used to evaluate these. One valuation basis is whether A_s is an appropriate answer to Q_p as in the preceding section. We calculated a precision for each evaluator. This precision was calculated by the following formula.

$$\text{Precision} = \frac{\#\text{total correct answers}}{\#\text{total answers judged by the system}} \qquad (5)$$

The result is given in Table 3.

Table2. Threshold value of each method

Method	Threshold
bi-gram	0.404
tri-gram	0.308
morpheme	0.346
tf-idf	0.440
dependency parsing	0.136

Table3. Experiment result

Evaluator	Precision
Evaluator 1	0.124
Evaluator 2	0.101

Table4. Correct example

Posted Question	"What is the concrete difference between a 'blog'(s currently popular word), and a 'BBS'? "
Similar Question	"What is a blog? Is it different from a BBS? "
Answer	"A blog is a web diary. A BBS is a web page written by the general public."

Table5. Incorrect example

Posted Question	"What is the concrete difference between a 'blog'(s currently popular word), and a 'BBS'? "
Dissimilar Question	"What is the difference between a comment and a trackback on a blog?"
Answer	"A comment expresses an opinion and feedback about an article within the blog. A trackback is a notice isuued when the article is referred to by others."

5. DISCUSSION

Correct example

Table4 provides a correct example. The answer to a similar question is an appropriate answer to the posted question.

Incorrect example

Table5 provides an incorrect example. The system has judged a question that is not similar to be similar. We think this caused by the method for setting the threshold.

Idea for an improvement

To improve the threshold, we considered how to take an average from similar question pairs**.** In such a method, we prepare some pairs of questions that are similar by hand, and the average of these similarities is defined as a threshold.

In addition, we considered each technique separately this time. Therefore, we think that precision may be improved by an ensemble method that mixes the techniques. We calculate the similarity by the following formulas.

$$\text{similarity} = \frac{\sum_{i=1}^{n} V_i}{n} \qquad (6)$$

Here, V_i is the value that normalized the similarity in method i. In the future, we want to conduct experiments to confirm the effectiveness of this method.

Furthermore, the system sometimes judges a question to be different with regard to the intention of the question from an otherwise similar question. For example, the question "Who is Washington?" is different from "Where is Washington?". However, because "Washington" appears in both questions, they might be judged to be similar. We may be able to prevent such incorrect conclusions from the system if we add a tag to the question automatically (or by hand). For example, we may tag the first question as "a question about a place," and the second question as "a question about a person." We would also like to confirm the effectiveness of this approach.

6. CONCLUSIONS

In this paper, we proposed a system that can present a question that is similar to a question posted by a user. The proposed system measures the similarity of the question sentence by calculating the cosine similarity based on uni-grams, tri-grams, morphemes, tf-idf, and dependency parsing. The experiment result demonstrates that the system can show a questioner the answer to a similar question. However, the system has still number of aspects that should be improved.

In the future, we would like to reconsider the method for setting the threshold and to develop a new method for distinguishing questions.

7. REFERENCES

[1] Soojung Kim, Jung Sun Oh, Sanghee Oh,"Best-Answer Selection Criteria in a Social Q&A site from the User-Oriented Relevance Perspective", **Proceedings of the American Society for Information Science and Technology,** Volume 44, Issue 1, pp.1–15, 2007.

[2] Yoko Nishihara, Naohiro Matsumura, Masahiko Yachida," Understanding of Writing Style Patterns between Q&A in Knowledge Sharing Community", **The 22nd Annual Conference of the Japanese Society for Artificial Intelligence**, 2008.

[3] Daisuke Ishikawa, Tetsuya Sakai, Yohei Seki, Kazuko Kuriyama, Noriko Kando, "Automatic Prediction of High-Quality Answers in Community QA ", **The Japanese Society for Artificial Intelligence**, Vol. 21, No. 3, 2011, pp.362-382.

[4] Naoto Watanabe, Satoshi Shimada, Yohei Seki, Noriko Kando, and Tetsuji Satoh, "A Study for Questions Classication based on Questioner Demands in QA Communities", **DEIM Forum**, 2011.

[5] F. Maxwell Harper, Daniel Moy, Joseph A. Konstan, "Facts or Friends? Distinguishing Informational and Conversational Questions in Social Q&A Sites", **CHI Q&A Systems**, 2009, pp.759-768.

[6] Long Chen, Dell Zhang, Mark Levene, "Understanding User Intent in Community Question Answering", **WWW 2012 – CQA'12 Workshop**, 2012, pp.823-828.

[7] Akihiro Tamura, Hiroya Takamura, Manabu Okumura, "Classification of Multiple-sentence Questions", **Information Processing Society of Japan**, Vol. 47, No. 6, 2006, pp. 1954-1962.

[8] Liqiang Nie, Meng Wang, Zheng-Jun Zha, Guangda Li and Tat-Seng Chua, "Multimedia Answering: Enriching Text QA with Media Information", **SIGIR '11**, 2011, pp.695-704.

[9] Y. Matsumoto, A. Kitauchi, T. Yamashita, andY. Hirano. Japanese morphological analysis system chasen version 2.0 manual. Technical report, **NAIST**, 1999.

Decrypt of a Vigenère Message in Spanish using Word frequencies

Sánchez Rinza Bárbara Emma,
Meritorious Autonomous University of Puebla, Computer Science Department
Puebla ,Puebla, cp 7200, México

and

Cruz Gómez Sergio Rodolfo
Meritorious Autonomous University of Puebla, Computer Science Department
Puebla ,Puebla, cp 7200, México

ABSTRACT.

Cryptology is the science dedicated to the study of the secret writing [1], i.e. studies the messages that, processed in a certain way, become difficult or impossible to read by no authorized entities.
With the new technologies on information and communication, and the massive use of digital communications, it has been produced an increasing number of security problems.
The objective of cryptology has been generalized to study the techniques in charge of giving security to the information. Cryptology shows us to encrypt information and to decrypt it. In this paper we shall proceed to decrypt a message in a Spanish language, to do that we shall use the Spanish language grammar, though if we want to use it for another language we simply follow the characteristics of the new language.
We shall start with the encrypted message by the Vigenère encryption [3]. Then we shall proceed with a letters frequencies analysis and most frequent words in the Spanish language.

Keywords: Cryptography, Frequencies, Clear message, decrypt, Vigenère.

adfa, p. 1, 2011.

1. INTRODUCTION

Cryptography is the discipline that is responsible of the study of secret codes, also known as cipher codes (in Greek kryptos means secret, and gráhos writing)

The bonanza of an encrypted code is based simply on how persistent it might be to the attacks of cryptanalysis techniques. The cryptanalysis techniques are classified based on the information the cryptanalyst knows [1]:

When we enter on the ground of military cryptography we must speak of Kerchoffs, who established the rules a cryptosystem[1] must have in order to avoid being broken by a cryptanalyst[1] (XIX century).

These rules are:

- There mustn't exist any way of recovering via the cryptogram the initial text or the key.
- Every cryptographic system must be composed by two kinds of information:
  - Public: Like the series of algorithms that define it.
  - Private: Like the key. In the asymmetric systems part of the key is also public information.

- The chosen key must be easy to record and modify.
- The cryptogram must be able to be transmitted using the usual media.
- The complexity of the recovering process of the original text must correspond with the obtained benefit [2].

2. FREQUENCIES ANALYSIS

In the cryptanalysis, the analysis technique of frequencies consist of the use of studies on the frequencies of the letters or letter groups in the languages to be able to establish hypothesis to use them to decrypt a cipher text without having the decrypt key (to brake the cipher text). It is a typical method to break classic encryptions.

The frequencies analysis is based on the fact that, given a text, certain letters or combinations of letters appear more than others, being different frequencies for them. Moreover, there exist a characteristic distribution of the letters that is practically the same for most of the examples of the Spanish language.

For example, in the Spanish language, the vowels are very common, occupying around 45% of the text, being the letter E and A the ones that appear the most, whereas the added frequencies of the letters F, Z, J, X, W and K doesn't reach 2%.

In some ciphers the natural properties of the text are preserved in the cipher text. Such schemes can potentially be objects of cipher text attacks.

2.1 FREQUENCY ANALYSIS FOR THE SIMPLE SUBSTITUTION

In a simple substitution algorithm, each letter from the clear text is replaced by other letter, and a letter given from the clear text will always be replaced to the same letter on the cipher text. For example, all the letters "E" will become "X". A cipher text with a high frequency of the letters "X" could suggest to the cryptanalyst [1] that the letter "X" represents the letter "E".

The basic use of the frequencies analysis consists first on calculating the frequency of the letters that appear on the cipher text and then associate letters from the clear text to them. A high frequency of "X" could suggest that the "X"'s are "E"'s, but this is not always true, because the letters "A" and "O" also have a high frequency in the Spanish language. However, it will be difficult that the "X"'s represent, in this case, to the "K" or the "W". Thus, the cryptanalyst [1] could have to try several combinations until decrypting the text.

The most complex statistics could be used, like considering pairs of letters or even three letters words. This is done to give more information to the cryptanalyst [1]. For example, the letters "Q" and "U" are almost always together in Spanish, meanwhile the letter "Q" alone is rare.

3. VIGENÈRE CIPHER

The Vigenère cipher resembles a lot to the Cesar cipher algorithm [1] but with the difference of the used key in this algorithm is more complex, in the Cesar algorithm [1] a number is used to represent the number of letter shifts of the alphabet, but in the Vigenère cipher [3] a word is used, from which the letters are taken as the corresponding shifts. Each letter of the key corresponds to a position on the alphabet and it will tell us the number of shifts to be made.

The clear text is decomposed in letters and is to be put in a single line. The Vigenère cipher [3] will take the first letter of the clear text and the number of shifts from the first letter from the key, then it will do the same with the second letter of the clear text and the second letter from the key, it will do this process until the clear message is encrypted. In the case that the key is shorter than the clear text, which is usually the case, we shall begin with the first letter of the key again.

Let's define the clear text as $text$ and the key as key, now we shall define the length of the key as $keyLength$ and the message length as $textLength$, then we have that $keyLength < textLength$, then we shall begin from the start of the key, this is, when we encounter ourselves on the letter i of the clear message $text$ and $i = keyLength + 1$ we shall take the first letter and start again to go over the key, this can be represented as well with the modulus operation $j = i \bmod keyLenght$, where j is the letter of the key which will be taken to do the shifts.

With this we will be able to encrypt the entire message with the same key, although we can see that the smaller the key the behavior of the cipher is more like the Cesar cipher [1], which we don't want to happen.

4. LETTERS FREQUENCY OCCURRENCE

The frequency of the letters depends of the used language, so first we must define the language. We

will be using the Spanish language. Now we will analyze this language with its respective frequencies.

The calculation of the letters frequency in a language is difficult and it's subject to interpretation. We count the frequency of the letters of an arbitrarily long text, but in the results influence many parameters:

- The narrative style: If there are many infinity verbs, there will be many "R"'s.
- The specific vocabulary of the document: If you speak of "ríos" (rivers in Spanish) there will be many "í"; if the protagonist is named Wenceslao, the number of "W" will rise.
- The document type: In small announcements we can find many currency symbols (€, $, Bs, etc), which is possible they will be absent on the most part of other kind of documents.
- In the RAE dictionary, the most frequent letter is "A", but in any Spanish text the frequency of the words "que", "el", "se", "me", etc, makes the "E" be the most frequent.
- The technical parameters: We can easily calculate statistics about computerized texts, but often, these do not imply the use of upper cases with accent (which sometimes turn out to be complicated to type). Besides, some authors omit the accenting.
- The presence of non alphabetic characters (punctuation signs, numbers, parenthesis, mathematic symbols, etc) can or cannot be taken into account. The comma and the point, for example, are more frequent than half of the letters.

If these parameters have a spectacular impact on the least frequent symbols, is also sensible even for the most frequent letters.

The occurrence percentage of the letters in Spanish is presented on figure 1.

Letter	Percentage	Letter	Percentage
A	12.53	O	8.68
B	1.42	P	2.51
C	4.68	Q	0.88
D	5.86	R	6.87
E	13.68	S	7.98
F	0.69	T	4.63
G	1.01	U	3.93
H	0.70	V	0.90
I	6.25	W	0.02
J	0.44	X	0.22
K	0.01	Y	0.90
L	4.97	Z	0.52
M	3.15		
N	6.71		
Ñ	0.31		

Fig. 1. Occurrence percentage of the letters

Ordered from higher to lower occurrence frequency we have: **E A O S R N I D L C T U M P B G V Y Q H F Z J Ñ X W K**.

From the previous data we can say that:

- The vowels will occupy around 45% of the text.
- The E and A are the most easily identifiable given by their occurrence percentage.
- The most frequent consonants are: S, R, N, D, L and C (they appear with a 30% frequency)
- The six least frequent letters are: Z, J, Ñ, X, W and K (added they have a frequency that is barely over 1.5%)

Now, the percentages come with letters from the text. What we will see next is a more accurate analysis using now the words with one, two, three and four letters. This will also be using the words frequencies, which we will show in the next table, ordered from higher to lower frequency vertically.

One letter	Two letters	Three letters	Four letters
Y	DE	QUE	PARA
A	LA	LOS	COMO
O	EL	DEL	AYER
E	EN	LAS	ESTE
	SE	POR	PERO
		CON	ESTA
		UNA	AOS
		MAS	TODO
		SUS	SIDO
		HAN	SOLO

Table 1. Order by words frequency [4]

This helps us in the analysis, because we can do the same process we use with the letters but using words, starting with the one-letter words, giving more priority the less letters the words have. And the same way that with the letters, we do a letters substitution that don't correspond with the letter, for example, the word "QUE" with the word "QIE", in this example we can see that is the word with the highest probabilities to be, simply because it's the three-letter word that shows the most in the Spanish vocabulary, thus we will substitute the letter "I" with the letter "U" and we will leave the other letters as they are. We shall proceed the same way until we finish with the most frequent three-letter words, so we can then go to the four-letter words.

This process helps us to improve the given results, because it gives us more information about the language.

5. MATERIALS AND METHODS

Now we will see more specifically the problem we want to solve, which is to decrypt a message that has been through a cipher substitution process, this algorithm is the Vigenère encryption [3].

We have the text on figure 2, which is the clear text, without any encryption.

```
Un cuento es una narracion breve que es creacion o ficcion de uno o vari
escritos o leyendas, cuya trama es protagonizada por un grupo reducido d
El cuento es transmitido en origen tanto por via oral como escrita, aunq
 dar cuenta de hechos reales o fantasticos pero siempre partiendo de la
Suele contener pocos personajes que participan en una sola accion centra
Su objetivo es despertar una reaccion emocional impactante en el lector.
Aunque puede ser escrito en verso (en forma total o en forma parcial), g
preponderancia de la narracion sobre el monologo, el dialogo, o la descr
En resumen, un cuento es una obra de ficcion que se desarrolla en cierto
personajes, los puntos de vista, los conflictos, y el desenlace.
```

Fig. 2. Clear text (Fragment)

We need the text to be long enough so the frequencies can match as much as possible, although is not always the case.

Besides, we have to be careful that the clear text is not from a scientific nature, or that it uses uncommon words, because it affects directly on the letter frequencies.

Now, we will use a letters substitution algorithm called Vigenère [3].

We will use the word "uno" ("one" in Spanish) for the substitution algorithm. The result is shown in figure 3.

```
OA QORBNB SM HBU AOLEOWVCH OFYIS KHS YF QLROWVCH B TCPQCBB XR IHB C PNFCE
RGWEWNBG I YSSRBXNG, WHMU GFUZO YF DLBHUTCHVNUQO JBF OA ULHDI ESXHQCQC XF
SF PIYAHI RG NEOHFACGWXB SH BFCTSH GOHGC JBF PVO IEOF PCGB SMPFCGO, UHBK
 QOL PIYAHU QS BRQBBG LROFRG I SOHGOMGWWBG JRFI FWYZDLR DUEHCRBXB RY YO \
MHSFR QIAHYASL CCWBG JRFMBBUWSM DIY COLGWWVDUA SH HBU FCFN OWPWIA QYAHLNZ
FI IOXYGWPB SM QSMCSLGOL HBU ESUPQCBB YZCWVCHNZ CZDUPHUAHY RB YY ZYPHIE.
OOAEOR DORRY FSL RGWEWNB SH ISLFC (YA TIEAU GCNNZ I RB ZBFGN DUEQCNZ), AF
CFYCCHQSLNBWVO XR ZU AOLEOWVCH FCVES YY AIACFBUI, RZ XVOFBUI, B ZU QSMPFC
YA FYFIGRB, OA QORBNB SM HBU BPLN RY SWWPWIA EOR GY QSMNFLBZFN SH PWYEHI
DYEGIAODRG, FBG JHBNBG XR JCFHU, YCM PCHSZCPHIF, M YY RYFSHYOWR.
QFNGCPOGRBNR, IH PIYAHI FS WNFUPHYEWTN DIE GO PCLGO YKHYAGCBB JHSM CCL PV
QSMNFLBZFN IHN VCFHIEWU, L OFYW MBZUZSHGS JBRLN FYPCHBQYEGY HB WYWGNL. YA
 ZI DIY TSHRFUYAYAHY AC UPCHGSWR OTA SF PIYAHI. IO KHS YFHY FCVFS NRRT OS
```

Fig. 3. Cipher text (Fragment)

This algorithm will do a shift on the letter depending of the corresponding letter from the key "uno", for example, on the letter "U", it would do a shift to the right by 20.

The next step is to use the frequencies algorithm. First we must define how we are going to attack the problem, in order to be able to decrypt we know that the Vigenère encryption is used. Then the next step is to find the length of the key that was used to encrypt the message. In order to do this we will need to try with many lengths and we will try to solve it from each one of them, starting with the length of 2, because If it were of length 1 it wouldn't make sense to use this algorithm. The first thing will do is assume that the key length is 2, and we will separate the text in the letters positions $1, 3, 5, 7, 9, \ldots$ from the ones in the positions $2, 4, 6, 8, \ldots$ since each of these two parts were encrypted by a different shift, having done this we will simply use the frequencies algorithm used to decrypt the Cesar encryption [1], namely, we will count the letters of each part and get the one that appear the most, in order to match them with the Spanish language frequencies and substitute them. In figure 4 we show the result of the letters counting in each of the parts.

```
General Output
----------Configuration: <Default>----------
Ordered Array:

Letter: F frequency: 194 Pos: 1          Letter: C frequency: 194 Pos: 1
Letter: C frequency: 192 Pos: 2          Letter: H frequency: 191 Pos: 2
Letter: Y frequency: 190 Pos: 3          Letter: Y frequency: 186 Pos: 3
Letter: H frequency: 166 Pos: 4          Letter: B frequency: 183 Pos: 4
Letter: R frequency: 165 Pos: 5          Letter: F frequency: 177 Pos: 5
Letter: B frequency: 162 Pos: 6          Letter: R frequency: 173 Pos: 6
Letter: S frequency: 155 Pos: 7          Letter: O frequency: 168 Pos: 7
Letter: O frequency: 150 Pos: 8          Letter: A frequency: 141 Pos: 8
Letter: N frequency: 149 Pos: 9          Letter: N frequency: 140 Pos: 9
Letter: G frequency: 140 Pos: 10         Letter: U frequency: 135 Pos: 10
Letter: I frequency: 132 Pos: 11         Letter: G frequency: 133 Pos: 11
Letter: U frequency: 122 Pos: 12         Letter: S frequency: 118 Pos: 12
Letter: A frequency: 120 Pos: 13         Letter: I frequency: 116 Pos: 13
Letter: U frequency: 115 Pos: 14         Letter: W frequency: 98 Pos: 14
Letter: Q frequency: 108 Pos: 15         Letter: Q frequency: 86 Pos: 15
Letter: V frequency: 82 Pos: 16          Letter: V frequency: 85 Pos: 16
Letter: M frequency: 75 Pos: 17          Letter: M frequency: 84 Pos: 17
Letter: E frequency: 72 Pos: 18          Letter: L frequency: 82 Pos: 18
Letter: P frequency: 69 Pos: 19          Letter: Z frequency: 71 Pos: 19
Letter: Z frequency: 64 Pos: 20          Letter: P frequency: 70 Pos: 20
Letter: L frequency: 63 Pos: 21          Letter: E frequency: 64 Pos: 21
Letter: J frequency: 42 Pos: 22          Letter: X frequency: 49 Pos: 22
Letter: D frequency: 38 Pos: 23          Letter: J frequency: 30 Pos: 23
Letter: X frequency: 38 Pos: 24          Letter: D frequency: 27 Pos: 24
Letter: T frequency: 19 Pos: 25          Letter: T frequency: 24 Pos: 25
Letter: K frequency: 9 Pos: 26           Letter: K frequency: 6 Pos: 26
Letter: Ñ frequency: 0 Pos: 27           Letter: Ñ frequency: 0 Pos: 27
```

Fig. 4. Frequencies result

Then we will substitute each letter with their respective frequencies letter. This gives us as a result what is shown in figure 5.

```
DD BIRSLS IV SSP DDYYIUGAA DROMI WSU OR BYRIUGAA N XAHBENS ÑN
NCPYPLSC M OUINNZLT, UAVC CRPQD OE ÑFSSCXESGLCBI ZSE IM CFAJM
UE HTOMAT NC LYISRMECPÑS IA NRAXIA CISTA JNR QGD MYIE HATN UV
 BIF HTOMAP BI SRBNSC YRIENC M IISTDVCPUSC JRRT RUOHÑFN JCVAA
VSUEN BMMAODIY AEUSC JRRVSNCUUV ÑTO AIFTUPGÑPD IA SSP RARL IU
RT MDZOTUHN UV BIVAUFTDY SSP FICQBASN OHEUGAALQ AQJCQAPDSO RS
DIMFDN JIRNO RIY RTUFULN US MIYEE (OD XMYDP TALLQ T NN QNRCL
EEOAESBIVLSUGD ZR QP DDYYIUGAA EEGFI OO DTDARNCT, NH ZGIESPM,
OD EOEMCNN, IM BDNNLN UV ANC NHFL RO IPUHUMM FDN CO BUVLEYNQE
JOYTTDDÑRT, ESC JSSLSC ZR JARSC, OEV HAAIQAHSME, V OO ROEUSOD
BELCEQICNNLR, MS HTOMAT RI PLRPHSOYPXL JMY TD HAYCI OWSOMTASN
BIVLRFSHRL MSL GEEATFUC, F IEOU VNQPQIACU ZSRYL ROHAANBOFCO S
 QT ÑTO XUSNECODODSO ME PHAACUUN BMM UE HTOMAT, YD WSU ORSO E
RNT EGMECUV NNLYU DD BIRSLS V IMI SSZOOI USELL TTD TA CISTA Z
```

Fig. 5. Substitution result (Fragment)

Now what we have to do is to verify if this length of 2 is very likely to be the one used for the encryption, for this, what we will do is use the frequencies of the two-letter words of the Spanish language as shown on table 1.

As we can see, all five most common two-letter words of the Spanish language have the letter "E" or the letter "A". We will use this information to define

if the text is decrypted with a key of that length. Now what we are going to do is the same frequencies algorithm but now applied to the two-letter words from the cipher text. The ordered words are shown in figure 6.

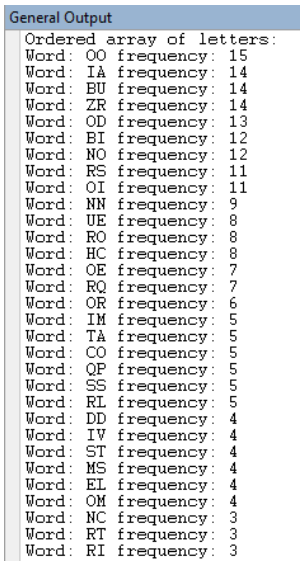


Fig. 6. Ordered two-letter words

As we can see, not all the first 5 words on the list contain the letter “E” or the letter “A”, which tells us that the key is not of length 2. Thus we will try with length 3.

With the previous process, we shall separate the text in 3 parts and we will count the letters in each one of the parts as shown in figure 7.

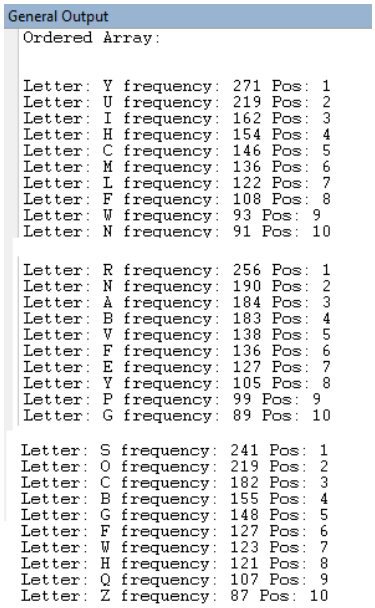


Fig. 7. Ten most frequent letters from the cipher text

Now we will substitute the letters of the frequencies in the cipher text, which gives us as result what shows in the figure 8.

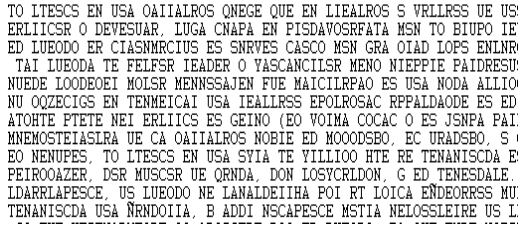


Fig. 8. Letter substitution (Fragment)

After that we will count the letters of length 2 and we will order them. Which gives us as result what shows on figure 9.

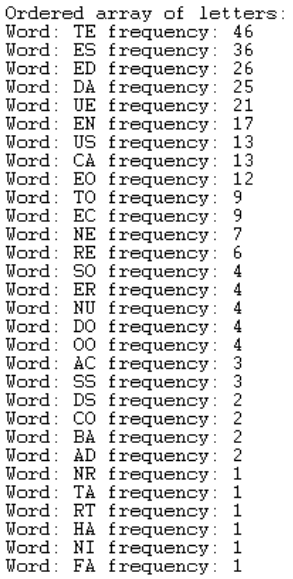


Fig. 9. Letters frequencies of length 2

As we can see, the first 5 words of the list contain the letter “E” or the letter “A”, thus the length of 3 can be a good option for the key. Therefore now we shall decrypt the key. To do this we will simply compare the most frequent letter from each part with the most frequent letter from the Spanish language, which the letter “E” and we will calculate the shifts needed to go from the letter “E” to the most frequent letter from each part, as shown in figure 10.

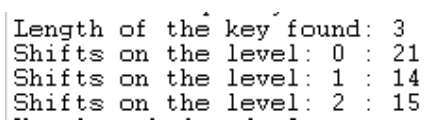


Fig. 10. Shifts needed in each level

Finally, to verify it we will use the key to decrypt the cipher text, simply subtracting the key to the cipher text. The result is shown in figure 11.

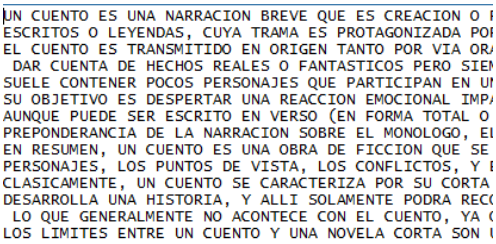


Fig. 11. Decrypted text using the found key (Fragment)

As we can see the result is as expected, we have decrypted the text completely, there is a possibility that in any of the parts is more frequently the letter "A" than the letter "E" because they are not that far away in the frequency table, but still it is possible to decrypt without any problems.

6. CONCLUSIONS

This decryption method is effective against encryption algorithms of substitution, where the message is reflected on the cipher text, but also depends on the text itself. The text has to be close to the language frequencies that are being taken in count (in this case Spanish).

Besides, the algorithms performance depends on the key, the longer it is the longer it takes to decrypt.

The algorithm could decrypt entirely the message. We must say that this could change depending on the message itself, because if we don't have a large enough message we cannot do a good analysis, moreover, as the key is larger, we will need the message to be larger as well, because the message is broken depending in the keys length, if the message is not long enough the parts will not have the frequencies that match with the language.

As we can see, the Vigenère encryption [3] is more complicated than the Cesar encryption [1], because is composed by many implementations of the Cesar encryption [1], this gives us a greater complexity when we encrypt a text. In this paper we show how we can break the Vigenère encryption [3], and therefore, the Cesar encryption [1], having the enough text to be able to break it, with the enough information so the probabilities match with the languages probabilities, this tells us that in order to break the Vigenère encryption we by this method we need a lot more information than if we want to break the Cesar encryption, in fact, la amount of information needed to brake the Vigenère encryption can be seen as proportional to the Cesar encryption, by multiplying the number of elements in the key (letters) in the Vigenère encryption.

We also need to know that the complexity of the Vigenère encryption remains on knowing the keys length, because when we know the keys length the complexity is technically the same as the Cesar encryption, with only a few differences.

Finally we will say that the Vigenère encryption is more viable than the Cesar encryption because the implementation is very alike in both the encryptions, con very few different details between them, and also the Vigenère encryption increases the complexity of the encrypted message, which in the end is what we look for, to protect our information.

7. BIBLIOGRAPHY

1. Gibrán Granados Paredes, "Revista Digital Universitaria",**Introducción A La Criptografía**, volumen 7,pag. 17,julio 2006, ISSN 1067-6079.
2. R. de M. García,"**Criptografía clásica y moderna**",primera edición,Enero, 2008, Septem Ediciones, ISBN: 978-84-96491-79-3.
3. YumnamKirani Singh, "**ARPN Journal of Engineering and Applied Sciences**", Generalization Of Vigenere Cipher, Vol. 7, Pag. 39, January 2012, ISSN 1819-6608.
4. Sánchez Rinza Barbara E., Bigurra Zavala Diana Alejandra, Corona Chavez Alonso, "De-encryption o fa text in spanish using probability ans statistics", **conielecomp,** vol18,,2008,isbn 076953120 2

A Comparison of Self-selection Regression Modeling with Weighting of Observations in Adjusting for Missing Survey Data

Philip Serumaga-Zake
School of Business Leadership (SBL)
University of South Africa
Pretoria, South Africa

and

Raghunath Arnab
Department of Statistics
University of Botswana
Gaborone, Botswana

ABSTRACT

This paper compares self-selection regression modeling with weighting of observations in adjusting survey data for missing data. The signs of estimates do not differ but seemingly, weighting adjustment is more effective than self-selection regression in terms of the percentage of variation explained by the model. The results suggest that the relative quality of adjustment for MAR using self-selection regression depends on the strength of the correlation between IVs and the dependent variable and/or the extent to which the interaction between the IVs and the dependent variable affects missing data on the dependent variable. The combination of both approaches gives the best results if data are both MAR and NMAR.

Key words: missing survey data, MAR, NMAR, weighting adjustment, self-selection regression model

1. INTRODUCTION

In almost all large-scale surveys, occurrence of missing data is inevitable - even when the best tools and strategies are used (see, Kalton & Kasprzyk, 1986; Brick & Kalton, 1996; Elliot, 1991 and Little & Rubin, 1987). Missing data mainly occur for two reasons: **noncoverage** and **nonresponse** (Allison, 2001). Noncoverage occurs when some units in the target population have no chance of being selected into the sample (i.e., when the sample frame is not complete or up-to date and so the sampled population is not the same as or equal to the target population). Nonresponse occurs when the interviewer fails to obtain data from the sampled units. There are two types of nonresponse: (1).unit nonresponse, which occurs when a sampled population unit fails to participate in the survey (for e.g., because he/she cannot be located, refuses to participate or is too ill to participate), and (2) **item nonresponse,** which occurs when a sampled unit participates in the survey but fails to provide a response to one or more of the survey questions (for e.g., because they are too sensitive or personal, he/she does not know the answer, an interviewer fails to ask a question or record the answer, or recorded responses are deleted in editing a questionnaire for the response is inconsistent with the answers recorded for other questions). This study focused on nonresponse. There is a potential for bias in estimates of the population parameters whenever sampled persons who did not participate in the survey or participants who refused to furnish information have different characteristics from the characteristics of those who did. If such differences exist and no attempt is made to adjust for them in the analyses, inferences about the target population may be misleading. The potential for this kind of bias is particularly great when the nonresponse rate is high, say higher than 40%.

The methods of handling missing data include: post stratification, response modeling, imputation and randomized response techniques (Rubin, 1987; Kish, 1992; CBASSE, 2001). The best way to reduce the bias in estimates that might be caused by nonresponse however is to try to achieve a high response rate through careful planning and implementing field procedures that maintain a high level of cooperation (CBASSE, 2001). In this study, self-selection regression method (using the Heckman selection model) and weighting adjustment were compared in adjusting survey data for missing data – using the Stats SA's[1] 1999 October household survey (OHS) data. Section 2 presents the theoretical framework and literature review and section 3 contains the results and the conclusion.

2. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

The size of nonresponse bias depends on the amount of nonresponse and the difference between the respondent and nonrespondent mean values of the study variable. Three different missing data scenarios can be identified: Missing Completely At Random (MCAR), Missing At Random (MAR) and Not Missing At Random (NMAR). For MCAR, the probability that an observation (Y_i) of the dependent variable, Y, is missing is unrelated to a value of any independent variable (IV), Xi or to value Yj (for i, j = 1, … , n). If it is related to Xi, we get a scenario of MAR. Otherwise, if it is related to Yj, we get a scenario of NMAR. Therefore, as an example, data on personal income would be considered NMAR if people with higher incomes were less likely to report their incomes than people with lower incomes. Similarly, if Whites were more likely to omit reporting income than Blacks, we would not have data that were MCAR because missing data would be correlated with ethnicity – a scenario of MAR. If data are MCAR, the most common method is to simply omit those observations with missing data, ignore nonresponse and run the analyses on what remains (Howell, 2001). For MAR, the proposed methods are, for example, listwise deletion, pairwise deletion, mean substitution, imputation, regression methods, Expectation Maximization (EM), Full Information Maximum Likelihood (FIML) and weighting adjustment. In the case of NMAR, one can use self-selection regression models and pattern-mixture models (Howell, 2005; Little & Rubin, 1987; Wothke, 1988; Heckman, 1979).

In this study, the income model was fitted on age, gender, race, area of residence, education, employment status, marital status and relationship to the head of household to compare four sets of estimates from: (1) unweighted data, (2) a self-selection regression model, (3) weighted data (obtained by using poststratification) and (4) weighted data (obtained by using logistic regression). SAS was used.

3. RESULTS

Before the income model was fitted, the data were tested for MAR and NMAR using logistic modeling and the joint multinomial probability distribution respectively. The data were

[1] Statistics South Africa is the government agency, which is charged with collecting official statistical data of the republic of South Africa.

found to be MAR and NMAR. The definitions of the variables used and their corresponding mean values are shown in Table 1 (Appendix).

Tables 2, 3 and 4 (in Appendix) show the estimation results of the log income model for all people, males and females respectively. It should be noted that weighting adjustment with weights calculated from a logistic model caused serious linear relationships among some of the IVs especially "area" and "gender". Though "area" was excluded from the model to minimize the multicollinearity problem, the resulting estimates could still have been affected.

Table 2 has significant results for age, area, gender, race, employment status and relationship with the head of household. Adjusted R-square is about 0.420 meaning that about 42.0% of the variation in income is explained by the model. The self-selection regression model gives a slight improvement over the unweighted data regression model in that, the adjusted R-square increased (though slightly) to 0.421. The mill's ratio is highly significant (Pvalue<0.0001) implying that fitting the income model without adjusting for nonresponse would have biased the estimation results.

Using the reciprocals of inclusion probabilities as weights to adjust the survey data for nonresponse made an improvement in the results, both in terms of adjusted R-square (0.444) and total number of significant estimates at the 10% level of significance. In this case, "primary" and "father/mother" are significant as well. Weighting the observations using logistic model weights also improved the analysis greatly over the unweighted data regression analysis. Adjusted R-square went up to 0.442. The results are far better (in terms of R-square and total number of significant estimates) than those obtained from unweighted data and the self-selection regression model. Though the adjusted R-square of the weighted data (with logistic model weights) regression is high (0.442), significant estimates are similar to those of the unweighted data and the self-selection regression model.

The results from unweighted data in Table 3 demonstrate that age, area of residence, race, employment status and relationship to the head of household determine income for men. Adjusted R-square is 0.422. The self-selection model changed the results somehow. Though the adjusted R-square is the same (0.422), variable "primary" is now highly significant (at the 5% level of significance). The mill's ratio is also significant (Pvalue=0.02). Using inclusion probabilities to weight observations raised the adjusted R-square to 0.442. Variables: "primary", "brother/sister" and "father/mother" are significant only at the 10% level of significance instead of at the 5% level of significance as is with the previous regressions (especially that of the self-selection regression model). Using logistic model weights for missing data adjustment also improved the results. Adjusted R-square is the same as for weighted data (with inclusion probabilities' weights) at 0.442. Variable "primary" is not significant just like in the case of unweighted data regression but "brother/sister" is highly significant at the 1% level of significance.

Table 4 demonstrates that all variables except "grandparent/great grandparent" affect income according to the unweighted data regression. The mill's ratio variable in the self-selection regression model is highly significant (Pvalue<0.0001). In general, the signs of estimates in the weighted data regression models and self-selection regression models are the same as those for the estimates in the unweighted data regression models but there are some differences in statistical significance between them. The adjusted R-square is more or less the same at 0.404. Using weighted data (with inclusion probabilities' weights) improved the results greatly in terms of statistical significance and adjusted R-square (0.442).

Discussion

It has been found that generally, weighting of observations (with inclusion probabilities' weights) out-competes the self-selection model both in terms of R-square and total number of significant estimates. Table 5 (Appendix) compares the four approaches of missing data adjustment in terms of adjusted R-square and total number of significant estimates.

The signs of the estimates in the fitted income models are the same. There was a tradeoff between R-square and the total number of significant estimates in the case of weighted data regressions (with logistic model weights) compared to unweighted data regressions. For example, in Table 2, adjusted R-square is 0.419 with 3 non-significant estimates (unweighted data) whereas adjusted R-square is 0.442 and 4 non-significant estimates (i.e., less significant estimates) for the weighted data regression.

According to Table 5, weighted data regression (with inclusion probabilities' weights) has the highest adjusted R-square of 0.444 and the smallest number of non-significant estimates of 1 for all people. Unweighted data regression has the lowest adjusted R-square of 0.419 but weighted data regression (with logistic model weights) has the highest number of non-significant estimates of 4 – possibly due to the multicollinearity problem. For males, both weighted data regressions have the highest adjusted R-square of 0.442 but weighted data regression (with inclusion probabilities' weights) and self-selection regression have the smallest number of non-significant estimates of 2. In the case of females, we have larger differences between the approaches. Like for males, weighted data regression (with inclusion probabilities' weights) has the highest adjusted R-square of 0.442 followed by the weighted data regression (with logistic model weights) with adjusted R-square of 0.431. Weighted data regression (with inclusion probabilities' weights) has the smallest number of non-significant estimates of 1. Self-selection regression has the highest number of non-significant estimates of 5 followed by the weighted data regression (with logistic model weights) with 4 non-significant estimates. Weighted data regression (with inclusion probabilities' weights) is the best followed by weighted data regression (with logistic model weights) and then self-selection regression. As expected, unweighted data regression is the worst.

It is interesting to note that different magnitudes of estimates were obtained for the different missing data adjustment approaches (though the differences were not tested for statistical significance) and these differences were greatest for females where we had a very highly significant Mill's ratio. In this particular case, the magnitudes of estimates for weighted data were closer to those for unweighted data than to the magnitudes of the estimates for self-selection regression. For example, in Table 4, the estimate for Coloureds in the unweighted data regression model is 0.202*** compared to 0.230*** for weighted data (with inclusion probabilities' weights), 0.302***

for weighted data (with logistic model weights) but 0.022 for the self-selection model. For age group "21 – 40" they are 0.361*** for unweighted data, 0.349*** for weighted data (with inclusion probabilities' weights), 0.400*** for weighted data (with logistic model weights) and 0.065 for the self-selection model. The differences are not that large for males in which case the Mill's ratio is less significant. This implies that the probability of obtaining survey data from males is higher than that of obtaining it from females.

4. CONCLUSIONS

In *conclusion*, the results have suggested that, for the NMAR scenario, though weighting adjustment seemingly gives a higher R-square and more significant IVs, using self-selection regression models might be a better option as far as obtaining valid and unbiased results is concerned. The effect of adjusting survey data for MAR by using self-selection regression depends on the strength of the correlation between IVs and the dependent variable and/or the extent to which the interaction between the IVs and the dependent variable affects missing data on the dependent variable. The combination of the approaches performs better if the data are both MAR and NMAR. Further research is needed.

5. REFERENCES

[1] P.D. Allison, **Missing data**, Thousand Oaks, CA: Sage, 2002.

[2] Baxter, S.S., and Marsh, Testing for and correcting for missing data in survey responses: A survey of downtown businesses in Minneapolis, Baxter Econometrics University of Notre Dame, L.C. 2005 accessed at http://www.nd.edu/~meg/LSR/SAS/shelley.html.

[3] J.M. Brick and G. Kalton, "Handling missing data in survey research", **Statistical Methods in Medical Research,** Vol. 5, 1996, pp. 215– 238.

[4] Commission on Behavioral and Social Sciences and Education (CBASSE), Studies of welfare populations: Data collection and research issues, 2001.

[5] D. Elliot, **Weighting for Non-Response: A Survey Researcher's Guide,** London, England: Office of Population Censuses and Surveys, Social Survey Division, 1991.

[6] J.J. Heckman, "Sample Selection Bias as Specification Error", **Econometrica**, Vol. 47, 1979, pp.153-161.

[7] D.C. Howell, Treatment of missing data, 2005 accessed at http://www.tufts.edu/~gdallal/itt.htm, accessed on 3/5/2013.

[8] V.G. Iannacchione, J.G. Milne and R.E. Folsom, Response probability weight adjustments using logistic regression. pp. 637–642 in Proceedings of the Section on Survey Research Methods, American Statistical Association. Alexandria, VA: American Statistical Association, 1991.

[9] G. Kalton and D. Kasprzyk, „The treatment of missing survey data", **Survey Methodology,** Vol. 12, No.1, 1986, pp. 1–16.

[10] L. Kish, "Weighting for unequal P_i", **Journal of Official Statistics**, Vol. 8, 1992, pp. 183–200.

[11] R.J.A. Little, and D.B. Rubin, **Statistical Analysis with Missing Data**, New York: Wiley, 1987.

[12] Stats SA, **October Household Survey**, Pretoria: Statistics South Africa, 1999, 2000.

Appendix

Table 1: Definitions of Variables and means

VARIABLE	DESCRIPTION	Means		
		Males	females	All
MISSI	Missing data: miss=1 if income is missing but miss=0 if income is not missing	0.040	0.030	0.035
income	monthly income in Rands	587.19	386.41	480.84
Age group				
<21 years	ages (in completed years) of less than 21 years (excluded from the model)	0.504	0.453	0.477
21 – 40	ages from 21 to 40 years	0.297	0.307	0.302
41 - 65	ages from 41 to 65 years	0.163	0.187	0.176
66 +	ages from 65 on wards	0.036	0.053	0.045
Race				
Blacks	excluded from the model	0.791	0.793	0.792
Coloureds		0.114	0.1145	0.114
Indian/Asians		0.021	0.021	0.021
Whites		0.074	0.072	0.073
Area	Area of residence: area=1 for urban but area=0 for rural	0.532	0.525	0.528
Education				
No education	excluded from the model	0.204	0.212	0.208
Stds 1 – 4	primary school	0.342	0.311	0.326
Stds 5 - 10	secondary school	0.411	0.431	0.421
Std 10 +	Std 10 + cert., diploma & degree (tertiary education))	0.042	0.045	0.0435
Marital status				
Married or living tog.	excluded from the model	0.267	0.270	0.269
Div./sep, or wid./widow	Divorced/separated, or widower/widow	0.028	0.093	0.062
Single	Never married	0.705	0.637	0.669
Relat. to head				
Head	Head/acting head of the household (excluded from the model)	0.3095	0.1745	0.2385
partner	Wife/husband/partner	0.011	0.2015	0.111
Son/daughter	Son/daughter/stepchild/adopted child	0.418	0.3745	0.395
Brother/sister		0.035	0.032	0.033
Father/mother		0.002	0.008	0.005
Grandparent	Grandparent/great grandparent	0.000	0.001	0.0005
Grandchild/other	Grandchild/great grandchild/other relatives (e.g. in-laws or aunt/uncle)	0.2145	0.201	0.207
Non-related pers.		0.010	0.008	0.009
Employ. status				
employed	excluded from the model	0.438	0.290	0.358
unemployed		0.109	0.112	0.110
not-econ.	not-economically active	0.453	0.5985	0.532

Table 2: Regression estimates for the log (income) function: all people

Variable	Unweighted data	Self-selection regression model	Weighted data by using "inclusion probabilities"	Weighted data by using a logistic model
	estimate	Estimate	Estimate	estimate
Intercept	5.928***	6.039***	6.005***	6.241***
Age group (in years)				
21 – 40	0.412***	0.248***	0.409***	0.399***
41 – 65	0.523***	0.316***	0.504***	0.467***
65 +	0.701***	0.598***	0.662***	0.593***
Gender (male)	0.188***	0.127***	0.180***	0.238***
Area (urban)	0.274***	0.241***	0.277***	-
Race				
Coloured	0.182***	0.075***	0.219***	0.295***
Indian/Asian	0.495***	0.208***	0.484***	0.517***
White	0.831***	0.397***	0.819***	0.851***
Education				
Primary	0.009	-0.002	-0.025*	0.026
Secondary	0.371***	0.252***	0.340***	0.399***
Tertiary	1.215***	0.954***	1.123***	1.146***
Employment status				
Unemployed	-0.928***	-0.928***	-0.978***	-1.130***
Non-econ.active	-0.472***	-0.475***	-0.504***	-0.686***
Marital status				
Div/sep. or/and widower/widow	-0.148***	-0.146***	-0.165***	-0.149***
Never married	-0.283***	-0.289***	-0.293***	-0.285***
Relationship with head				
Husband/wife/partner	-0.188***	-0.181***	-0.171***	-0.123***
Son/daughter/stepchild/adopted child	-0.081***	-0.077***	-0.093***	-0.127***
Brother/sister	-0.094***	-0.094***	-0.107***	-0.142***
Father/mother	-0.057	-0.053	-0.082*	-0.103
Grandparent/great grandparent	-0.085	-0.083	-0.207	-0.139
Grandchild/great grandchild or/and other relative (e.g. in laws or aunt/uncle)	-0.099***	-0.102***	-0.077***	-0.164***
Non-related persons	-0.110***	-0.102***	-0.141***	-0.065
Mill's ratio	-	2.253***	-	-
No. of observations	33544	33544	33544	19503
Adj. R-square	0.419	0.421	0.444	0.442

Note: *, ** and *** mean significant at 10%, 5% and 1% level of sig., respectively

Table 3: Regression estimates for the log (income) function: males

Variable	Unweighted data	Self-selection regression model	Weighted data by using "inclusion probabilities"	Weighted data by using a logistic model
	estimate	Estimate	Estimate	estimate
Intercept	6.066***	6.106***	6.118***	6.543***
Age group (in years)				
21 – 40	0.446***	0.382***	0.454***	0.404***
41 – 65	0.554***	0.464***	0.545***	0.468***
65 +	0.683***	0.645***	0.682***	0.551***
Gender (male)	-	-	-	-
Area (urban)	0.339***	0.327***	0.329***	-
Race				
Coloured	0.166***	0.121***	0.215***	0.292***
Indian/Asian	0.418***	0.284***	0.420***	0.463***
White	0.840***	0.648***	0.838***	0.874***
Education				
Primary	0.073	0.061***	0.043*	0.043
Secondary	0.436***	0.384***	0.408***	0.397***
Tertiary	1.113***	1.013***	1.041***	1.005***
Employment status				
Unemployed	-1.134***	-1.134***	-1.159***	-1.310***
Non-econ.active	-0.633***	-0635***	-0.654***	-0.839***
Marital status				
Div/sep. or/and widower/widow	-0.179***	-0.178***	-0.195***	-0.170***
Never married	-0.314***	-0.313***	-0.318***	-0.289***
Relationship with head				
Husband/wife/partner	-0.142***	-0.142***	-0.154***	-0.204***
Son/daughter/stepchild/adopted child	-0.089***	-0.087***	-0.098***	-0.182***
Brother/sister	-0.093**	-0.095**	-0.072*	-0.139***
Father/mother	-0.237**	-0.233**	-0.211*	-0.285**
Grandparent/great grandparent	0.116	0.111	-0.021	-0.040
Grandchild/great grandchild or/and other relative (e.g. in laws or aunt/uncle)	-0.135***	-0.136***	-0.120***	-0.244***
Non-related persons	0.014	0.018	-0.033	0.038
Mill's ratio	-	0.769**	-	-
No. of observations	16489	16489	16489	9823
Adj. R-square	0.422	0.422	0.442	0.442

Note: *, ** and *** mean significant at 10%, 5% and 1% level of sig., respectively

Table 4: Regression estimates for the log (income) function: females

Variable	Unweighted data	Self-selection regression model	Weighted data by using "inclusion probabilities"	Weighted data by using a logistic model
	estimate	estimate	Estimate	estimate
Intercept	5.883***	5.994***	5.971***	6.065***
Age group (in years)				
21 – 40	0.361***	0.065	0.349***	0.400***
41 – 65	0.490***	0.161***	0.459***	0.481***
65 +	0.710***	0.534***	0.643***	0.639***
Gender (male)	-	-	-	-
Area (urban)	0.218***	0.145***	0.225***	-
Race				
Coloured	0.202***	0.022	0.230***	0.302***
Indian/Asian	0.571***	0.171***	0.551***	0.583***
White	0.844***	0.147*	0.823***	0.840***
Education				
Primary	- 0.038**	-0.024	-0.072***	0.006
Secondary	0.322***	0.114***	0.286***	0.411***
Tertiary	1.335***	1.837***	1.228***	1.295***
Employment status				
Unemployed	-0.701***	-0.697***	-0.759***	-0.915***
Non-econ.active	-0.329***	-0.328***	-0.365***	-0.539***
Marital status				
Div/sep. or/and widower/widow	-0.115***	-0.115***	-0.122***	-0.087***
Never married	-0.213***	-0.211***	-0.202***	-0.204***
Relationship with head				
Husband/wife/partner	-0.107***	-0.112***	-0.082***	-0.021
Son/daughter/stepchild/adopted child	-0.051**	-0.048**	-0.066***	-0.062**
Brother/sister	-0.093**	-0.093**	-0.138***	-0.145***
Father/mother	-0.083*	-0.070	-0.106**	-0.087
Grandparent/great grandparent	-0.173	0.158	-0.278**	-0.209
Grandchild/great grandchild or/and other relative (e.g. in laws or aunt/uncle)	-0.062**	-0.066**	-0.032	-0.074*
Non-related persons	-0.271***	0.262***	-0.256***	-0.189**
Mill's ratio	-	4.893***	-	-
No. of observations	17055	17055	17055	9679
Adj. R-square	0.401	0.404	0.442	0.431

Note: *, ** and *** mean significant at 10%, 5% and 1% level of sig., respectively

Table 5: Comparison of missing data - adjustment approaches

Serial No.	Adjustment approach	Adjusted R-square	Non-significant estimates	No. of non-significant estimates
All people				
1	Unweighted data	0.419	Primary, father/mother and grandparent/grand grand parent	3
2	Self-selection regression model	0.421	Primary, father/mother and grandparent/grand grand parent	3
3	Weighted data (inclusion probabilities' weights)	0.444	grandparent/grand grandparent	1
4	Weighted data (logistic model weights)	0.442	Primary, father/mother grandparent/grand grandparent and non-related persons	4
Males				
1	Unweighted data	0.422	Primary, grandparent/grand grandparent and non-related persons	3
2	Self-selection regression model	0.422	grandparent/grand grandparent and non-related persons	2
3	Weighted data (inclusion probabilities' weights)	0.442	grandparent/grand grandparent and non-related persons	2
4	Weighted data (logistic model weights)	0.442	Primary, grandparent/grand grandparent and non-related persons	3
Females				
1	Unweighted data	0.401	grandparent/grand grand parent	1
2	Self-selection regression model	0.404	"21-40" yrs, Coloured, primary, father/mother and grandparent/grand grandparent	5
3	Weighted data (inclusion probabilities' weights)	0.442	grandparent/grand grandparent	1
4	Weighted data (logistic model weights)	0.431	Primary, husband/wife/partner, father/mother and grandparent/grand grandparent	4

An Examination of the Role of Social Influence and Organizational Hierarchy on Knowledge Management System Usage

Cherie E. Fretwell, PhD
Sorrell College of Business, Troy University
Phenix City, AL 36869

Carmen C. Lewis, PhD
Sorrell College of Business, Troy University
Phenix City, AL 36869

Jim Ryan, PhD
Sorrell College of Business, Troy University
Phenix City, AL 36869

ABSTRACT

Recent work on the social nature of relocating knowledge identifies knowledge management and its facets as a complex process, going well beyond the simple transfer of bundles of knowledge. This increase in the number of knowledge transfer studies has also led to new insights regarding knowledge management systems (KMSs). Still, we know little about the role of social influence in stimulating individuals to share through KMSs. Thus, we propose a framework for examining the role of social influence at different levels of the organizational hierarchy and its effects on KMS usage. Specifically, the research model examines the moderating effect of the hierarchical level of an employee on the relationship between prior KMS use by employees at various hierarchical levels and current KMS use. We define a set of propositions based on social influence theory to further our understanding of how organizations can facilitate knowledge sharing within their boundaries.

Keywords: knowledge management, social influence, hierarchical model

1. INTRODUCTION

Knowledge management has become an increasingly important phenomenon in recent MIS literature. Knowledge management (KM) can be defined as "how an organization manages its collective expertise and subject matter knowledge" [1]. With the development of information systems focused around storing and sharing knowledge, many scholars have devoted more attention to increasing these efforts. Recent work on knowledge transfer has identified its complexities, going well beyond relocating bundles of knowledge [2-4]. This increase in the number of knowledge sharing studies has also led to new insights regarding knowledge management systems (KMSs). However, little is known regarding the role of social influence factors in promoting or restricting knowledge sharing through KMSs. Therefore, the purpose of this study is to propose a framework for understanding the role of social influence and its relationship with knowledge contribution within an organization.

In addition to understanding the relationship between social influence and knowledge contribution, there is also a need to understand the effects of social influence at multiple levels in an organizational hierarchy. This study adopts the use of a newer and less often used data analysis technique, hierarchical linear modeling. To date, few studies in the social sciences have examined such topics while differentiating social influence among superiors, subordinates, and coworkers. Specifically, this study seeks to answer the following research question: How does social influence among different levels in the organizational hierarchy affect contribution and knowledge acquisition regarding a KMS?

The rest of this study is presented as follows: First, the theoretical frameworks used in this study are described. The development of specific propositions to be measured is then presented, along with the proposed research model. A discussion of the proposed methodology follows, concluding with contributions, limitations, and implications for future research.

2. THEORETICAL DEVELOPMENT

The Unified Theory of Acceptance and Use of Technology

Explanations of how individuals use technology and its antecedents largely draw on Venkatesh's [5] Unified Theory of Acceptance and Use of Technology (UTAUT). Although individual use of technology is one of the most heavily researched areas in information systems [6, 7], UTAUT was recently extended to UTAUT2, spurring new adoption papers in the field. Its constructs include performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, and habit, along with three individual difference constructs – age, gender, and experience. UTAUT2 is a highly successful theoretical model derived from eight individual technology acceptance models, boasting an R^2 of 74% in behavioral intention and 52% in technology use from its seminal study [5] [8] . Aligning with the theoretical perspective of UTAUT2, this study focuses on the constructs of facilitating conditions and habit, which leads to the first two of our propositions:

Proposition 1: An individual's KMS use is positively related to his/her facilitating conditions.

Proposition 2: An individual's KMS use is positively related to his/her habits.

Social Influence Theory

The motivation to share knowledge is quite complex, and depending on their particular culture, organizations may vary in expectations of knowledge sharing. The amount of knowledge shared with employees, especially overall strategic planning information, can be limited by those at the highest levels of an organization. However, much information needed for effective decision making should be available in an accessible repository to enhance organizational performance and perhaps achieve a greater competitive advantage. This would allow an organization to use and transfer knowledge among its workforce. How and why employees contribute this knowledge as well as the functionality of a specific KMS that promotes high levels of usage are important questions as employee use may be a consequence of social relationships [9].

According to Kelman's social influence theory, three theoretical processes influence an individual's attitudes, beliefs, and behaviors by referent others: compliance, internalization, and identification [10]. First, compliance transpires as individuals perceive pressure to behave in a certain way, in order to either gain rewards or avoid punishment. Secondly, internalization occurs when an individual consciously or unconsciously assimilates others' opinions and acts in harmony with them. Lastly, identification processes lead individuals to assume behaviors which conform to those of a respected social group in order to create an advantageous relationship with them [10]. As organizational members conduct their everyday work lives, these three processes reveal themselves in ways that directly impact daily operations and productivity outcomes. As an example, some employees may tend to withhold knowledge or information from others for a variety of reasons, which is a natural human tendency [11]. When organizations offer incentives, such as pay for performance, this may also discourage knowledge sharing because employees may prefer to use information to their personal advantage [12]. However, when limited knowledge sharing occurs within an organization, the possibility increases that gaps in knowledge will occur, which are likely to produce unpleasant work-related outcomes [13]. Early work by Kelman established that individuals often seek to maintain a favorable image within a reference group [10]. If the people in one's work group believe that he or she should enact a particular behavior, such as using a KMS, then using the system would tend to raise a person's status within the group. This example illustrates the *identification* process in Kelman's social influence theory. Increased status within one's work group can be the basis of power and influence because of processes that impact employee interaction, such as social exchange, coalition formation, and resource allocation [14]. As individuals continue to perform behaviors consistent with the expectations of their work groups, "the increased power and influence resulting from elevated status provides a general basis for greater productivity" [15]. Individuals may also perceive that using a KMS, as in our example, will lead to improvements in their job performance. "This result is consistent with social exchange theory, indicating that the goal for people sharing their knowledge is for building long-term relationships" [16, 17]. Social exchange theory comes from the intersection of economics, psychology and sociology to increase understanding of social behavior, or more specifically, the movement of resources, in economic trades [18]. It views the exchange relationship as "actions contingent on rewarding reactions from others" [19]. For instance, individuals who give much to others try to get much from them, while those who get much from others feel compelled to give much to them, creating a balance through give and take. Power results from this resource dependency, helping to shape the relationship [20]; it also originates from the structure [21].

Knowledge Management Systems

Organizations are learning that knowledge management systems are a key resource for storing and retrieving information that facilitates tasks and work routines. The movement of knowledge across individual and organizational boundaries into repositories and into organizational routines and practices is ultimately dependent on employees' knowledge-sharing behaviors. Knowledge management systems (KMSs) can be defined as "IT-based systems developed to support and enhance the organizational processes of knowledge creation, storage/retrieval, transfer, and application"[22]. KMSs include systems, polices, processes and procedures used to manage this creation, storing, sharing, and, ultimately, the reuse of knowledge [22-24]. KMSs derive from Knowledge Management (KM), which has been defined as "the process of capturing, storing, sharing, and using knowledge" [11, 25]. Spender and Scherer proposed that KM consists of the following components: people, processes, technology, culture, and structure [26]. These components represent the foundation of a KMS. On a day-to-day basis to actually operationalize managing knowledge, a KMS would certainly be "more than just the totality of systems in an information technology department" [1]. In order to effectively manage knowledge, an organization would be required to "consciously create a KMS" [1]. A KMS enables an organization to "systematically manage knowledge in order for its workforce to acquire, create and use knowledge to innovate and compete in the marketplace" [1].

The capability of organizations to manage knowledge strategically is one of the most significant sources of competitive advantage [27]. Organizational members should value the exchange of knowledge and expand on knowledge shared within an organization. "Organizational members ought to be prepared to throw in their knowledge and react to others' knowledge so that organizational knowledge can be sealed and innovative knowledge can be created and readily accessible for competent members inside the organization and potential utilization with the help of KM systems" [28]. "Successful knowledge sharing through KMSs depends on both knowledge contributors populating KMSs with content and knowledge seekers retrieving content from KMSs for reuse" [29]. In essence, the KMS provides for knowledge exchange in order to facilitate knowledge reuse. Knowledge management processes have been found to be significant predictors for organizational creativity. "Business organizations can achieve strategic and economic benefits of knowledge management by utilizing organizational creativity in an effective fashion"[23].

Prior experience also helps individuals understand the true benefits of a KMS and its relevance to their jobs. Those who have used a KMS and have achieved favorable results are more likely to use it again because of their positive beliefs and anticipation that benefits will continue to accrue [30]. Greater experience with a KMS can lead to more familiarity with the

system and technology, which may enable more effective usage [8]. Additional research reveals that *beneficial* past behavior has a positive effect on future behavior. Furthermore, some researchers assert that past usage is the only antecedent of future usage, even to the extent that it overshadows the impact of intention to use [15].

As with most information systems, the success of a KMS depends upon the extent of use, which may be tied to system quality, information quality, user satisfaction, individual and organizational impact, and usefulness of information [22, 31]. To enhance the quality of a KMS, "research focusing on KMS use process, and development of intuitive search, retrieval, and display, is needed" [22]. System quality itself is "influenced by attributes such as ease of use, characteristics of human-computer interface, and flexibility and effectiveness of search mechanisms" [17, 22]. Although systems use is common in many businesses today, the "most difficult part of a knowledge management system is not the technology or the structure of the information. These are simple tools not the actual content. The true work is in creating an atmosphere where all team members and staff members are comfortable with an environment of sharing" [32].

Researchers also suggest that one of the most common information systems perspectives is that "technology utilization is governed by the match between technology features and the requirements of the task" [33]. As rational and experienced users, individuals tend to "select tools and methods that enable them to complete tasks with the greatest net benefit" [33]. In a study of KMS usage antecedents based on an analysis of data collected from 192 industries, the research findings indicated that their "results also give implications to the managers that employees' KMS usage are also influenced by their task interdependence, perceived fit between task characteristics and KMS functionalities and, most important of all, their confidence in usage" [29]. Thus, we posit the following proposition:

Proposition 3: An individual's KMS use is positively related to his/her prior KMS use.

To summarize the important findings related to KMS usage, we present the following table as a reference:

Table 1: Knowledge Management System Usage Research

Author	Study Content	Findings
Bock and Kim, 2002 [16]	Developing an understanding of the factors affecting the individual's knowledge sharing behavior in the organizational context.	Positive attitude toward knowledge sharing is found to lead to positive intention to share knowledge and, finally, to actual knowledge sharing behavior.
Damodaran and Olphert, 2000 [34]	A post-implementation review of usage and user experiences of an electronic information management system (EIM) in a multinational company.	Identification of the critical success factors for EIM provides the basis for a change management process.
Venkatesh and Morris, 2000 [30]	Investigating gender differences in the workplace in the context of individual adoption and sustained usage of technology.	Gender differences in perceived usefulness and perceived ease of use as antecedents of technology acceptance and use behavior.
Yang, Moon, and Rowley, 2009[35]	Improving understanding of the impact of social influences on different types of users' perceptions and adoption of IT.	Knowledge workers considering adopting innovative IT are sensitive to general perceptions of its usefulness.
Malhotra and Galletta, 2003 [36]	The role of knowledge workers' motivation and commitment in KMS implementation.	Commitment and motivation are significant antecedents to KMS usage in an organizational knowledge management program context.
Kankanhalli, Tan, and Wei, 2005 [17]	Formulating and testing a theoretical model to explain Electronic Knowledge Repositories (EKR) usage by knowledge contributions.	Knowledge self-efficacy and enjoyment in helping others significantly impact EKR usage by knowledge contributions.
Ghosh and Scott, 2007 [24]	Knowledge management processes and organizational enablers associated with effective knowledge management systems for a clinical nursing setting.	A simple technical system to support clinical KM will not address the diversity of tasks nurses routinely perform.
Aktharsha, Anisa, and Ali, 2012 [28]	Validating the research model and examining the effect of Organizational Trust within the Knowledge Management context.	Social factors have major influence on Knowledge Sharing behavior along with technological factors.
Bock, Zmud, Kim, and Lee, 2009 [37]	Developing an integrative understanding of the factors supporting or inhibiting individuals' knowledge-sharing intentions.	Attitudes toward subjective norms as well as organizational climate affect individuals' intentions to share knowledge.

Hierarchical-Level Social Influence

Organizations most able to build and prolong competitive advantage are those that leverage their "know-how in a methodical approach" [28]. "The key to leveraging the knowledge of an organization is providing insight, thought, leadership and context to those who benefit the most in generating and using organizational knowledge" [28]. Knowledge interchanges within organizations may take place top-down, bottom-up, or horizontally, depending on hierarchical structure and management styles [38]. The hierarchal status within an organization, the type of work, and responsibility of the person within the organization may help determine KMS usage. In addition, the hierarchy, including supervisors, subordinates, and peers, influences the usefulness of a KMS.

Social factors, affect, perceived usefulness, perceived ease of use, and facilitating conditions significantly affect KMS usage to share knowledge [28]. Results from a survey of academic faculty across a variety of disciplines regarding their beliefs about the use of internet technologies in their teaching revealed support for the hypothesis that "perceived social influence from referent others in support of the use of a technology has a significant positive influence on individual beliefs about the usefulness of that technology" [39].

Social influence is demonstrated through interactions between peers and between supervisors and subordinates. "Social influence is most likely to occur where communication is most pervasive" [40], thus individuals would be influenced by their most frequent communication partners. In the work setting, this would involve subordinates, peers, and superiors. An important measure of managerial effectiveness is the success achieved in influencing subordinates, peers, and superiors [41]. In studies analyzing power in a work setting, there is much agreement that superiors who believe they exert strong influence over their subordinates attribute the behaviors of their subordinates to their own personal influence rather than to aspects of the subordinates themselves [42].

A recent study further drawing on Kelman's [10] work involving KMS usage data of over 80,000 employees of a management consulting firm looked at the possibility that understanding two key processes underlying social influence as distinct and separate from compliance-based social influence might provide new insights and guidance for managers. "These two social influence mechanisms are likely to influence individuals' use of highly visible technologies like KMS (1) when individuals *identify* with a group and as a result adopt their behaviors, and (2) when they consciously or unconsciously *internalize* others' opinions and act in accordance with these assimilated opinions" [43]. The model used for this research focused on specific social groups whose behaviors might affect an individual's KMS use. The results revealed a "pattern of influence that varies systematically depending on a user's rank and the kind of reference group in question (peer, superior, subordinate, extended professional population)" [43]. Their analysis "confirms the presence of social influence effects on KMS use, and reveals that different reference groups influenced individuals at different hierarchical levels" [43] The practical implications of this study for managers include "understanding how various sources of influence are likely to affect employees' KMS use may improve their ability to diagnose the cause of a faltering KM initiative and take actions to create a critical mass of engaged and active users" [43].

In literature regarding training employees to use information technology, it is thought that training practitioners and researchers "focus primarily on skill acquisition and transfer at the *individual* level, rather than considering the broader sharing of attitudes, values, and norms at the *group* level" [44]. These authors further suggest that what actually transpires in training for technology usage is less related to acquiring specific skills and is more a "function of learners' assimilating attitudes and intentions to use IT from other members in the training setting" [44]. A specific hypothesis from their study was "*The level of an employee's IT usage will be related to the level of his coworkers' average IT use*," and they found very strong support for the hypothesis [44]. After controlling for employees' job type, these researchers still found that coworkers' average level of IT use was a strong predictor of the individual's IT usage, which means that "knowing whether an individual's coworkers use IT in their jobs helps to predict the individual's level of use, without regard for the particular job roles performed by these employees" [44]. These research findings would also suggest that employees in a work setting would be influenced by their coworkers and/or supervisors in using a KMS. Taking these discoveries into consideration, we posit the following propositions:

Proposition 4: *An individual's KMS use is positively related to his/her superiors' prior KMS use.*

Proposition 5: *An individual's KMS use is positively related to his/her peers' prior KMS use.*

Proposition 6: *An individual's KMS use is positively related to his/her subordinates' prior KMS use.*

Proposition 7: *Hierarchical level moderates the relationship between others' prior KMS use and an individual's KMS use such that individuals who have higher levels in the organizational hierarchy are less likely to be influenced by others.*

We propose the following research model to investigate the ways social influence, facilitating conditions, and habit influence an individual's KMS usage by suggesting it varies as a function of other employees' actual KMS usage, rather than perceived use (See Figure 1).

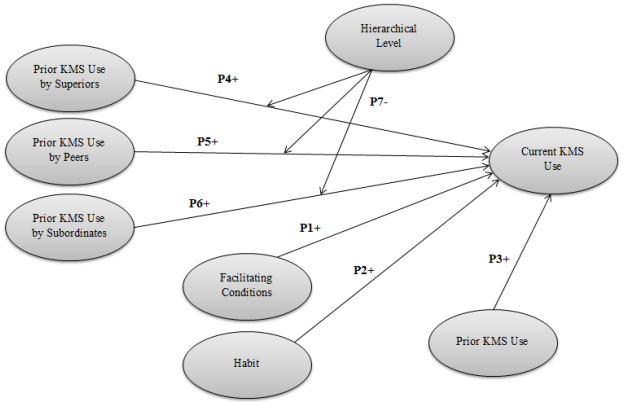


Figure 1. Proposed Research Model

3. DISCUSSION

This paper proposes the use of UTAUT2 and social influence theory for better understanding the relationship between actual KMS usage and social influence, facilitating conditions, habit, and prior KMS usage. It also introduces the importance of exploring organizational connections at various levels. In conjunction with the theoretical framework, we suggest the importance of examining the hierarchical levels in an organization to demonstrate how an individual's position in the network, relative to one's own, influences contribution to an IS. For instance, we would expect superiors to have more influence on individuals than subordinates. Thus, a supervisor's KMS

usage is likely to have a greater impact on his subordinate's KMS usage than the impact individuals' would have on each other at similar levels of the organizational hierarchy.

This paper takes the initial steps of model creation; however, only understanding the qualitative aspects of the proposed relationships is a limitation that leads to opportunities for future research. We propose future studies should empirically examine the suggested research model from this paper, while including several demographic variables along with the main constructs identified. Demographics, including but not limited to, gender, age, geographic location, culture, experience with KMS, and tenure within an organization have been shown to impact the usage of KMS. For example, males have been shown to be less risk averse compared to females, indicating their increased likelihood of experimenting with a KMS before their female counterparts. In Europe, specifically, "about twice the number of men than women above age 55 use a computer" [45]. In essence, along with gender, age appears to be a variable that could influence KMS usage. We would expect younger employees who are exposed to higher levels of technology at a younger age to be more likely to use a KMS.

4. CONCLUSIONS

In conclusion, the purpose of this study was to investigate and further assess how social influence among different levels in the organizational hierarchy affects contribution and knowledge acquisition regarding a KMS. A research model was developed and propositions were presented. The next step would be to examine these propositions and techniques to determine whether they are empirically supported. The findings from this study will provide several potential areas for further investigation on the usage of KMS at various hierarchical levels in an organization.

5. REFERENCES

[1] E. Fibuch and I. I. I. C. W. Van Way, "What Is a Knowledge Management System ... And Why Should I Care?," **Physician Executive**, Vol. 37, No. 5, 2011, pp. 34-39.

[2] R. J. J. Boland and R. V. Tenkasi, "Perspective Making and Perspective Taking in Communities of Knowing," **Organizational Science**, Vol. 6, No. 4, 1995, pp. 350-372.

[3] Y. Engestrom, "Expansive Visibilization of Work: An Activity–Theoretical Perspective," **Computer Supported Cooperative Work**, Vol. 8, 1999, pp. 63-93.

[4] C. Osterlund and P. Carlile, "Relations in Practice: Sorting through Practice Theories on Knowledge Sharing in Complex Organizations," **The Information Society**, Vol. 21, 2005, pp. 91-107.

[5] V. Venkatesh, M. G. Morris, G. B. Davis, and F. D. Davis, "User Acceptance of Information Technology: Toward a Unified View," **MIS Quarterly**, Vol. 27, No. 3, 2003, pp. 425-478.

[6] I. Benbasat and H. Barki, "Quo Vadis, Tam," **Journal of the Association for Information Systems**, Vol. 8, No. 4, 2007, pp. 211-218.

[7] V. Venkatesh, F. D. Davis, and M. G. Morris, "Dead or Alive? The Development, Trajectory and Future of Technology Adoption Research," **Journal of the Association for Information Systems**, Vol. 8, No. 4, 2007, pp. 267-286.

[8] V. Venkatesh, J. Thong, and X. Xu, "Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology," **MIS Quarterly**, Vol. 36, No. 1, 2012, pp. 157-178.

[9] W. He, Q. Qiao, and K.K. Wei, "Social Relationship and its Role in Knowledge Management Systems Usage," **Information & Management**, Vol. 46, No. 3, 2009, pp. 175–180.

[10] H. C. Kelman, "Compliance, Identification, and Internalization: Three Processes of Attitude Change," **The Journal of Conflict Resolution**, Vol. 2, No. 1, 1958, pp. 51-60.

[11] T. H. Davenport and L. Prusak, "Working Knowledge: Managing What Your Organization Knows," **Harvard Business School Press, Boston, MA**, 1998.

[12] G. P. Huber, "Transfer of Knowledge in Knowledge Management Systems: Unexplored Issues and Suggested Studies," **European Journal of Information Systems**, Vol. 10, No. 2, 2001, pp. 72-79.

[13] L. Baird and J. C. Henderson, **The Knowledge Engine: How to Create Fast Cycles of Knowledge-to-Performance and Performance-to-Knowledge**: Berrett-Koehler Store, 2001.

[14] J. Pfeffer, **Power in Organizations** Vol. 33: Pitman Marshfield, MA, 1981.

[15] V. Venkatesh and F. D. Davis, "A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies," **Management Science**, Vol. 46, No. 2, 2000, pp. 186-204.

[16] G. W. Bock and Y.-G. Kim, "Breaking the Myths of Rewards: An Exploratory Study of Attitudes About Knowledge Sharing," **Information Resources Management Journal (IRMJ)**, Vol. 15, No. 2, 2002, pp. 14-21.

[17] A. Kankanhalli, B. C. Tan, and K.-K. Wei, "Contributing Knowledge to Electronic Knowledge Repositories: An Empirical Investigation," **MIS Quarterly**, 2005, pp. 113-143.

[18] G. C. Homans, "Social Behavior as Exchange," **American Journal of Sociology**, Vol. 63, No. 6, 1958, pp. 597-606.

[19] P. Blau, **Exchange and Power in Social Life**. New York: Wiley, 1964.

[20] R. Emerson, "Power-Dependence Relations," **American Sociological Review**, Vol. 27, No. 1, 1962, pp. 31-41.

[21] K. S. Cook, "Exchange and Power in Networks of Interorganizational Relations," **The Sociological Quarterly**, Vol. 18, No. 1, 1977, pp. 62-82.

[22] M. Alavi and D. E. Leidner, "Review: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues," **MIS Quarterly**, 2001, pp. 107-136.

[23] H. Lee and B. Choi, "Knowledge Management Enablers, Processes, and Organizational Performance: An Integrative View and Empirical Examination," **Journal of Management Information Systems**, Vol. 20, No. 1, 2003, pp. 179-228.

[24] B. Ghosh and J. E. Scott, "Effective Knowledge Management Systems for a Clinical Nursing Setting," **Information Systems Management**, Vol. 24, No. 1, 2007, pp. 73-84.

[25] T. H. Davenport and L. Prusak, **Information Ecology: Mastering the Information and Knowledge Environment**: Oxford University Press, 1997.

[26] J.-C. Spender and A. G. Scherer, "The Philosophical Foundations of Knowledge Management: Editors' Introduction," **Organization**, Vol. 14, No. 1, 2007, pp. 5-28.
[27] R. M. Grant, "Toward a Knowledge-Based Theory of the Firm," **Strategic Management Journal**, Vol. 17, 1996, pp. 109-122.
[28] U. S. Aktharsha, H. Anisa, and S. D. Ali, "The Usage Behavior of Knowledge Management System in Hospitals," **IUP Journal of Knowledge Management**, Vol. 10, No. 2, 2012, pp. 22-44.
[29] T.-C. Lin and C.-C. Huang, "Understanding Knowledge Management System Usage Antecedents: An Integration of Social Cognitive Theory and Task Technology Fit," **Information & Management**, Vol. 45, No. 6, 2008, pp. 410-417.
[30] V. Venkatesh and M. G. Morris, "Why Don't Men Ever Stop to Ask for Directions? Gender, Social Influence, and Their Role in Technology Acceptance and Usage Behavior," **Management Information Systems Quarterly**, Vol. 24, No. 1, 2000, pp. 115-140.
[31] W. H. DeLone and E. R. McLean, "Information Systems Success: The Quest for the Dependent Variable," **Information Systems Research**, Vol. 3, No. 1, 1992, pp. 60-95.
[32] K. Kearns, "Evolution of a Corporate Knowledge Management and Knowledge Building Effort: A Case Study of Just-in-Time Training and Support of Laboratory Robotic Workstations Driven through Online Community Portals," **Journal of Systemics, Cybernetics and Informatics**, Vol. 3, No. 5, 2005, pp. 11-17.
[33] D. L. Goodhue and R. L. Thompson, "Task-Technology Fit and Individual Performance," **MIS Quarterly**, 1995, pp. 213-236.
[34] L. Damodaran and W. Olphert, "Barriers and Facilitators to the Use of Knowledge Management Systems," **Behaviour & Information Technology**, Vol. 19, No. 6, 2000, pp. 405-413.
[35] H. Yang, Y. Moon, and C. Rowley, "Social Influence on Knowledge Worker's Adoption of Innovative Information Technology," **Journal of Computer Information Systems**, Vol. 50, No. 1, 2009, pp. 25-36.
[36] Y. Malhotra and D. Galleta, "Role of Commitment and Motivation in Knowledge Management Systems Implementation: Theory, Conceptualization, and Measurement of Antecedents of Success," in *System Sciences*, **Proceedings of the 36th Annual Hawaii International Conference on System Sciences**, 2003, pp. 10.
[37] G. Bock, R. W. Zmud, Y. Kim, and J. Lee, "Behavioral Intention Formation in Knowledge Sharing: Examining the Roles of Extrinsic Motivators, Social-Psychological Forces, and Organizational Climate," **MIS Quarterly**, Vol. 29, No. 1, 2005, pp. 87-111.
[38] T. J. Mom, F. A. Van Den Bosch, and H. W. Volberda, "Investigating Managers' Exploration and Exploitation Activities: The Influence of Top-Down, Bottom-up, and Horizontal Knowledge Inflows*," **Journal of Management Studies**, Vol. 44, No. 6, 2007, pp. 910-931.
[39] W. Lewis, R. Agarwal, and V. Sambamurthy, "Sources of Influence on Beliefs About Information Technology Use: An Empirical Study of Knowledge Workers," **MIS Quarterly**, Vol. 27, No. 4, 2003, pp. 657-678.
[40] J. Schmitz and J. Fulk, "Organizational Colleagues, Media Richness, and Electronic Mail a Test of the Social Influence Model of Technology Use," **Communication Research**, Vol. 18, No. 4, 1991, pp. 487-523.
[41] G. Yukl and C. M. Falbe, "Influence Tactics and Objectives in Upward, Downward, and Lateral Influence Attempts," **Journal of Applied Psychology**, Vol. 75, No. 2, 1990, p. 132.
[42] A. P. Brief, R. J. Aldag, and C. J. Russell, "An Analysis of Power in a Work Setting," **Journal of Social Psychology**, Vol. 109, No. 2, 1979, p. 289.
[43] Y. Wang, D. B. Meister, and P. H. Gray, "Social Influence and Knowledge Management Systems Use: Evidence from Panel Data," **MIS quarterly**, Vol. 37, No. 1, 2013, pp. 299-313.
[44] M. J. Gallivan, V. K. Spitler, and M. Koufaris, "Does Information Technology Training Really Matter? A Social Information Processing Analysis of Coworkers' Influence on It Usage in the Workplace," **Journal of Management Information Systems**, Vol. 22, No. 1, 2005, pp. 153-192.
[45] H. Seybert, "Gender Differences in the Use of Computers and the Internet," **Eurostat, Statistics in Focus**, 2007.

A Formal Attempt on Definition of Knowing Sets

Xiaochen LIU
Department of Philosophy, Beijing Normal University
Beijing, 100875, China

and

Jiahong GUO
Institute of logic and cognitive science, Beijing Normal University, No.19 Xinjiekouwaidajie,
Beijing, 100875, China

ABSTRACT

This is a complement to a longer paper on first-order epistemic description of knowing sets from the perspective of extension. Both of the articles are proposing and investigating an analysis of knowing a recursive set for a rational agent. Using some plausible intuitions from epistemic logic and set theory, we defined the knowledge of a recursive set as knowing the elements of the set. Specifically, for any element *d*, if it belongs to *S* then the agent knows that, otherwise the agent knows that *d* does not belong to *S*. Our full version of this idea took place in the framework of first-order models, with the help of a standard first-order modal logic with a constant domain that contains all of the recursive sets as objects. The first-order definition of knowing sets is attempting to give a formal definition of knowledge-how and to connect mathematics with epistemic logic. In this article, we will explain how both of the attempts work and why we start from this approach.

Keywords: Knowledge-how, Knowing Sets, First-order Epistemic Language, Epistemology.

1. INTRODUCTION

Knowledge is the central subject that is under discussion from epistemology and epistemic logic. The rich literature in the field focuses mainly on propositions, and it is a tradition that is inherited from Aristotle [1] to treat knowledge in terms of such logical endeavors. While the human mind does not possess information as to what logicians and philosophers have prescribed, as a cognitive agent, human beings receive and develop not only *propositional knowledge* but also *procedural knowledge*. The simple separation between two genres of knowledge has been well accepted in cognitive science [11], psychology [4], computer science [15] and pedagogy [9]. Studies and practices in these fields guarantee the necessity of probing into both types of knowledge. However, it is now the case that we are facing an imbalanced development of the two types of knowledge in which knowledge-that is dominating the kingdom of epistemology, leaving knowledge-how desolated.

2. KNOWLEDGE-HOW

As yet there appears to be few acknowledged formal definition of knowing how [15]; (probably due to an incisive criticism from dialectic logic [18] that believes formalization will become a vicious circularity.) our first purpose is to provide the first-order epistemic description of procedural knowledge. We should note that such a description does not intend to solve the dichotomy between knowledge-how and knowledge-that but, instead, it is a formal attempt to grasp fragments of procedural knowledge and then simulate them in virtue of first-order propositions. A formalization apparatus cannot eliminate philosophical controversy over mind-body dichotomy (which is a central issue of dialectic logic [18]). However, it does help to give a rudimentary but well-comprehensible understanding in a logical system.

Unlike *declarative knowledge*, which is about the knowledge of "knowing that", procedural knowledge is about interactions with the world, about *knowing how*. At the same time, it is a great challenge in translating knowledge-how into propositions. Intuitively, a person might have a talent in riding bicycles, but we cannot yet teach a newbie only by words and physical instructions without personal drilling. More discussion can be found in Ryle's work

[13], but this approach is not our main direction. The point that I want to argue is that it no longer makes sense to insist on working merely with relations between propositions, and a new carrier form is required to fill this gap. Thus, as in our longer manuscript [10], we introduce *sets as predicates* into epistemic language to make this wish come true:

$$\forall x\big((S_x \rightarrow KS_x) \wedge (\neg S_x \rightarrow K\neg S_x)\big) \qquad (1)$$

Intuitively, it means that for any object x, if it belongs to *S* then the agent knows that, otherwise the agent knows that x does not belong to *S*. We denote knowing a set *S* in first-order epistemic language by:

$$\acute{K}S$$

(Read: the agent knows set *S*) For more technical details, see [10].

Interestingly, this approach is like what is suggested by Jason Stanley to build a bridge between the two types of knowledge by the mere transference of one to another, according to the following quote [16]:

the epistemic state is a ***species*** *of propositional knowledge. …Knowing how to F, like knowing where to F and knowing why to F, is a species of propositional knowledge.*

However, Stanley does not actually engage in solving the problem of formal translation of knowledge-how, but instead, in an informative and interdisciplinary way he proved it reasonable to believe in this approach. However, the propositions in his understanding appear to be more competent than what could be expressed in the propositional logic. I agree with Stanley's claim to translate statements such as "where to F", "why to F" and "when to F" into propositions, while the same translation will not work on statements like "how to F". Different from the other three kinds of statements, "how to F" is not merely a factual description but, instead, a judgment or a disposition. The significance of knowledge-how is to describe the possible approaches to objects rather than the state of objects, like the environment they are in, the time you perceive them or the reason why they exist. Thus, it will be dangerous to discuss the matter of having the right propositional knowledge or of knowing the right answer to the question "how could you do it?" which defines the knowledge-how by Stanley [16].

Thus what does it mean by knowing-how? Additionally, what is a well-acknowledged starting point to perceive the knowledge-how? We might date back to Ryle's definition [14] of knowing-how, and he thinks that it is a disposition whose

exercises are observances of rules or canons or the application of criteria.

To practice the criteria, which is similar to having a correct propositional knowledge of something, is an attempt to pick things out of a group into categories. As a result, it naturally urges us to switch to a discussion of the sets. For example, there is a set of rules for examining whether a batch of products are qualified or not, and after an agent applies the criteria, the batch collapses into two separated sets, for example, *the qualified* and *the unqualified*. Why does this dichotomy make sense in the process?

It makes sense because it allows us to achieve knowledge without the exact methods of acquiring it. On the other hand, we could approach the epistemic states (at least *imitate* the epistemic states) merely from the perspective of extension, avoiding taking the risk in a non-ending struggle with a defining intension. We are standing on behalf of determinism, and thus we believe that there must be a cause to determine the extension of a set, which is nothing more appropriate than the intention to be such a cause. Therefore, examining the elements of a set is by itself defining the intention. Thereby, procedural knowledge is the expansion of the results of a process that manifests in the cognitive operation of the presented results. The presented result is not only a proposition or a sentence but also a fact that an object is held by concepts. Crisp concepts can be expressed by virtue of set attributing. By working with sets, we are finally capable of simulating a part of knowledge-how in a first-order epistemic language and thus achieving the goal of bridging the gap between knowledge-how to knowledge-that in logical systems. Nonetheless, a first-order formula itself does not allow us to depict knowledge-how, so in a sense, knowledge-how is not just a single proposition of knowledge-that but rather the intention behind it. Only if subjects participate into the activities of judgment whether a given object belongs to a set or not, the formula will not be a mechanical data-processing but be a way to simulate the current epistemic states of agents.

3. SETS AND LOGIC

Andre Scedrov has proposed a basic epistemic set theory [19]. While, we are proposing a first-order description of epistemic states of knowing a set.

Besides denoting knowing-how, another important reason why we are attempting to study the interaction with sets is primarily because of the highly-axiomatized system of set theory. [7] This factor inspired us to combine set theory with epistemic logic and, at last, form a successful system. More remarkably, mathematicians' accumulative contributions helped us to develop further the possibilities of this combination. For simplicity, our attempt to define knowing a set basically relies on recursive sets, and as a starting point, we can eliminate a large amount of discernment on proofs and explanations. For example, for any recursive set *V*, there is a total computable function such that f(x) =1 if x belongs to V and f(x) =0 if x does not belong to V. This fact guarantees all the sets in the domain should be computable and thus the formula Ќ*S* is *decidable*. [5]

Therefore, we can foresee the immense potential of denoting objects in the domain of recursive sets and its application in artificial intelligence. Alan Turing [17] has proposed that every partial recursive function is *Turing-computable*. In other words, if a computing machine can understand our definition of knowing sets, then we can assign a theoretical meaning to the information that it is processing, that is to say, such a machine has an epistemic state currently, which means that it knows the set mentioned in a certain context. As a result, this definition might trigger further studies.

Second, the sets work well with first-order epistemic definition and also play a fundamental role in logic and mathematics. In light of our definition, a cooperation between sets and epistemic logic would surely provide many exciting facts and theorems. Primarily, set theory has a reliable theoretical background from an epistemological perspective. Owing to Cantor [3], we have both an intuitive and theoretical consciousness towards set because he said,

A set is a gathering together into a whole of definite, distinct objects (themselves are sets as well) of our perception [Anschluss] and of our thought - which are called elements of the set.

Proceeding from the fundamental work performed by Cantor, Zermelo and Fraenkel [7] axiomatized set theory by first-order formulas. With a solid theoretical foundation for mathematics, first-order logic will pave the way for building up a strong alliance with mathematical theories.

In addition, it is more vital to note the firm relation between sets and predicate logic. Predicate logic, originated by Gottlob Frege [8], is a historical improvement in the expressiveness of formal language, to allow us to define concepts by using nested quantifiers, while previous approaches are limited to representing inclusion relations exactly the way that Aristotle [1] and Kant [12] discussed in history. In predicate logic, capital letters are predicate letters, with different numbers of "arguments" (i.e., the objects that they relate) indicated [2]. A simple combination of capital letters and lowercase letters serves to denote concepts. In this case, concepts are construed as sets that hold objects, by which Frege created the origin of the conception in the extensional tradition that we are following. We do not think that it is necessary to reiterate the advantages of the extensional tradition nor to respond to philosophical criticism because, it will be a possibility in an epistemic description of knowing sets to overcome some of the shortcomings of the conception from the extensional perspective.

Our attempt is to introduce agents into the conception judgment where their *subjectivity* acquiesces to the examination of the extension of sets and the intention remains untouched and preserved in their minds. After this technical processing, we might acquire a cheering result that it is practicable to denote the epistemic states of the agents to know a concept through a *pseudo-intention* simulation. That is to pose questions to agents continuously from an anonymous interrogator. For a logical investigation, concepts should have a clear extension. For those vague concepts, we may discuss them later.

In the question games, we construe different concepts or collections of objects as sets. In each round of questioning and responding, we gradually establish the epistemic states of an agent to hold a concept. In the first step, we define what it means to a single object, in other words, to know exactly whether a given object belongs to a certain set. Then, the repetitive operation of criteria on the objects indicates the boundary of a set from a positive perspective. Finally, we determine the boundary from a negative perspective, to guarantee that the agent performs perfectly in the designated areas. An exciting thing to mention here is that all of the steps above can be realized on both human beings and Turing machines. It follows that it is possible to give a formal definition of knowledge that originated from Fichte's tradition [6] in a mechanical organism. We

hope that this approach can be a promotion in the field of artificial intelligence. It is obvious that our philosophical standpoint is no different from Turing Test [20], so Chinese room objection [21] is an incisive problem for all the Turing-Test-like question games and our proposal cannot escape responding to it. Our brief response is that Searle's request in his thought experiment is different from ours. A significant difference is that both of the inputs and outputs of Chinese room is Chinese character while our question game needs to test from a negative perspective, for example "Is the word 'Room' a part of Chinese?" Certainly, Searle will not include such questions as parts of his thought experiment. We will see more discussion in our longer paper [10].

Additionally, it is also promising results for cognitive science. Try to imagine when you are making a judgment on whether a given object belongs to a set or not, say whether an apple is red or not, and you will never try to list all of the elements in the set of $\{red\}$; instead, you check whether this object meets the criteria. We have not simulated this process in our definition, but that does not mean that we refute it; instead, we retain it as unsaid because no one can accurately exhaust the internal world of another agent. An extensional definition is not a compromise but is instead an approximation to the internal world. By far, it is the best way to simulate the cognition process and conception.

4. CONCLUSIONS AND FURTHER ISSUES

In this article, we have proposed and investigated an analysis of knowing a set for a rational agent. Using some plausible intuitions from epistemic logic and set theory, we defined the knowledge of a set as knowing the elements of the set. Compared with earlier attempts, we have not presented any additional axioms or proof methods (in contrast to classical first-order modal logic), to avoid the difficulty in the validity and completeness proof. Because we aimed to provide the simplest system as a prototype, a solid base property is at top priority. We will not probe into any validity and completeness proofs in particular for this is an introductory work of the complete paper [10] and thus it only means to portrait the developments of the related fields and explain the first-order definition of knowing sets in a multidisciplinary perspective. However, in our full version of the idea, you will get all the technical details in a stricter sense. The general base logic of our system is first epistemic predicate logic **S5** [2] plus the axioms BF (Barcan Formula) and CBF (Converse Barcan Formula) [22] for constant domains. Inside this full system, the logic of knowing sets in our sense will involve only a small fragment of the full language, but we have not determined its special properties [10].

Another obvious deficiency concerns the limitation of the K operator, which is slightly too strong for daily context. For example, knowing a group of people (e.g., people in Copenhagen School) does not necessarily mean that you can list all of their names, and often we say that we know a school when we know well the leading person. However, it is well defensible in what was presented above because it is either the given group is not a mathematical set or the agent does not know the se et in theoretical meaning where there are difficulties. Not to be a man away from practice, we should well consider the solution to the strict definition of knowing. There can be an appealing approach that we can make a finer distinction between not knowing and knowing. In other words, a hierarchy should be built to show how much an agent know about a set. It is easy to make some changes to the definition formula, to cope with the hierarchical denotation:

$$\exists x\big((S_x \to KS_x) \wedge (\neg S_x \to K\neg S_x)\big) \qquad (2)$$

This finding is just the dual of ḰS; <Ḱ>S we have defined before. If we replace the existential quantifier with a degree quantifier, then the degree of knowing a set can be expressed by the augmented language.

Furthermore, we know that all of the sets that we are discussing are determined sets, but there are more uncertain sets in our daily life. How to work on fuzzy sets and uncertain sets is a reasonable project after a well-defined basis. It appears that there is no need for us to reiterate the significance of knowing a fuzzy or uncertain set in several related fields with Artificial Intelligence and Philosophy. Besides, we are also working on how to introduce multi-agents into the definition. We are expecting whether our pseudo-intention attempt can keep performing well in a multi-agent circumstance.

5. ACKNOWLEDGEMENT

This work was sponsored by youth project of National Social Science Foundation of China (No. 09CZX032)

We are indebted to Jeremy Horne, Nagib Callaos, Yi Jiang, Fengkui Ju and anonymous reviewers for reading the manuscript and offering some helpful comments and suggestions for its improvement.

6. REFERENCES

[1] Aristotle, **The Complete Works of Aristotle**, Princeton: Princeton University Press, 1984.

[2] J. van Benthem, H. van Ditmarsch, J. van Eijck, and J. Jaspars. **Logic in Action**, University of Amsterdam, 2012.

[3] G. Cantor, **Beiträge zur begrürdung der transfiniten mengenlehre**, Mathematische Annalen, 46(4):481-512, 1875.

[4] N. J. Cohen, and L. R. Squire, "Preserved learning and retention of pattern-analyzing skill in amnesia: Dissociation of knowing how and knowing that", **Science**, 1980.

[5] R. Cori, and D. Lascar, **Mathematical Logic: A Course with Exercises, Part II.** North-Holland, 1973.

[6] J. G. Fichte, **Foundations of the Entire Science of Knowledge**, Appleton-Century-Crofts, 1970.

[7] A. Fraenkel. Y. Bar-Hillel, and A. Levy. **Foundations of Set Theory**, North-Holland, 1973.

[8] G. Frege, **Begriffsschrift, eine der arithmetischen nachgebildete Formelsprache des reinen Denkens**, Halle a. S, 1879.

[9] A. Gopnik and P. Graf., "Knowing how you know: Young children's ability to identify and remember the sources of their beliefs", **Child Development**, pages 1366-1371, 1988.

[10] J. Guo and X. Liu, **First-order Epistemic Description of Knowing Sets from the Perspective of Extension**, *Manuscript*, 2013.

[11] Z. He, K. C. Wang, V. Koprivica, G. Ming, and H. J. Song, "Knowing how to navigate: mechanisms of semaphoring signaling in the nervous system", **Science Signaling**, vol. 119, 2002.

[12] I. Kant, **Critique of Pure Reason**, Cambridge: Cambridge University Press, 1998.

[13] G. Ryle, **Knowing how and knowing that: The presidential address**, Proceedings of the Aristotelian Society, 46, 1945.

[14] G. Ryle, **The Concept of Mind**, London: Hutchinson, 1949.

[15] M. P. Singh, "Know-how", **Foundations of Rational Agency, Applied Logic Series**, pages 105-132. Kluwer, 1999.

[16] J. Stanley, **Know how**, Oxford University Press, 2011.

[17] A. M. Turing, "Computability and λ-definability", **The Journal of Symbolic Logic**, vol. 2.4: 153-163, 1937.

[18] Ilyenkov, Evald Vasilyevich, **Dialectical Logic; Essays on its History and Theory**, Aakar Books, 2008.

[19] Andre Scedrov, "Some Properties of Epistemic Set Theory with Collection", **The Journal of Symbolic Logic**, vol. 51, No.3, 1986.

[20] A. M. Turing, "Computing Machinery and Intelligence", **Mind**, no. 236: 433-460, 1950.

[21] J. R. Searle, "Minds, brains, and programs", **Behavioral and brain sciences**, 3.3: 417-457, 1980.

[22] G. Priest, **An introduction to non-classical logic**, Cambridge University Press, 2001.

Coping Occupational Stress with Serious Games

Msc. Renato de Aquino Lopes
Federal University of Uberlândia – Computer Faculty, Brazil. E-mal: renato@facom.ufu.br

Dr. Alexandre Cardoso
Federal University of Uberlândia – Faculty of Electrical Engineering, Brazil. E-mail: alexandre@ufu.br

Dr. Edgard A. Lamounier Júnior
Federal University of Uberlândia – Faculty of Electrical Engineering, Brazil. E-mail lamounier@ufu.br

Dr. Ederaldo José Lopes
Federal University of Uberlândia – Institute of Psychology, Brazil. E-mail: ederaldo@umuarama.ufu.br

ABSTRACT

Occupational stress is a serious problem that affects a large number of workers. Regardless financial or social status, age and profession, a person exposed to stress may develop health problems that can interfere with work and his quality of life. Thus, due to absenteeism and reduced productivity, companies lose money when its employees are stressed. In this scenario, it is important that employees use strategies to combat such drawback. Coping with occupational stress can be basically achieved, in two ways: problem-focused or emotion-focused. The literature shows that strategies that take into account the needs of individual workers have a greater chance of success. On the other hand, computer games offer players some experiences like: relaxation, sense of control, challenges, learning opportunities and immersion. These characteristics can contribute to the control process of occupational stress. The objective of this paper is to propose a new methodology for occupational stress, focused on emotion. In so doing, we use Serious Games and Virtual/Augmented Reality techniques, considering particular needs of the employee.

Keywords: Emotional stress, Human rehabilitation, Serious games, Virtual and augmented reality.

I. INTRODUCTION

Stress has become a serious problem that affects many people. When we consider stress in work environment, different people, regardless financial status, age and profession can be affected causing financial damage to companies and health problems to the worker himself.

It was identified in 2000, that the occupational stress in United States was the second most common cause of workers health problems [1]. In the European Union (EU) in 2005, it was found that occupational stress was the second health problem notified affecting 22% of workers [2]. In a survey in Brazil made by UNB (University of Brasilia) in 2011, revealed that more than 1 million workers were out of work and receiving sickness pay for problems caused by stress, depression, alcoholism and other [3].

Companies and governments spend too much money on the consequences related to stress at work. In 2002, the economic cost of work-related stress in the EU was estimated in € 20 million [2]. In Brazil, it is estimated that the damage will be 3.5% of GNP (Gross National Product) considering faults and medical license [3].

On the other hand, when one worker is continuously exposed to stress, he can develop psychological and physical problems that affect his performance at work and also his personal life. In recent years, the relationship between occupational stress and mental health workers has been researched due to alarming levels of temporary disability, absenteeism, early retirement and health risks associated with professional activity [4].

There are several initiatives that promote events, discussions and suggest practices to cope stress. The STRESSLESS project, started in 2010, has as main objective to develop and validate an international useful tool to combat stress in educators and educational institutions. One of the results of this project is the practical guide intervention in work-related stress [5]. Another initiative is the European Agency for Safety and Health at Work (EU-OSHA), which aims to make safer, healthier and more productive workplaces in Europe by promoting a culture of risk prevention to improve working conditions [2]. Brazil, along with other countries, participates of the International Stress Management Association (ISMA), which proposes to contribute to the orientation of technological applications

for the diagnosis and treatment of stress [6].

In this context, this paper aims to describe a proposal to cope with occupational stress using Serious Games throguh Virtual/Augmented Reality techniques. The work is divided as follows: Section II describes Occupational Stress related to the workplace. Section III shows some researches on Virtual Reality, Augmented Reality and Games-related with stress. Section IV presents this research proposal. Finally, Section V presents the conclusions and further research directions.

II. Occupational Stress

There are several stress definitions. Some addresses the biochemical aspect of the human body; other addresses behavioral aspects and still others the internal and external conditions that can cause stres

s. In [7], stress is defined as a imbalance ratio between environmental demands and personal resources, in which individuals perceive demands that deplete or exceed the resources they judge available to face the situation that is assessing for them as threatening for its balance. A common point in the definitions of stress is that they characterize the stress as the body's response to certain stressors.

Aspects involving the response to stressors are cognitive, behavioral and physiological. The effectiveness of these three levels ensures the person processing stressful information more quickly. This enables them to get proper conduct on this demand and facilitates a more positive body action [8].

When stress happens in the workplace it is called occupational stress. In [9], occupational stress is defined as a product of the relationship between the individual and the work environment, in which the demands of that environment exceeds the coping skills of the worker, causing excessive wear on the body and interfering with his productivity.

Examples of factors that can cause stress (stressors) are: unfavorable physical conditions, noise levels, excess heat, wear in interpersonal relationships, poor diet, sedentary lifestyle etc.

In [10], the symptoms of occupational stress are divided into three categories: physiological, behavioral and psychological. The physiological is related to changes in metabolism. The behavioral is observed in the changes related to productivity, absenteeism, increased smoking and alcohol consumption, etc. The psychological symptoms are observed in dissatisfaction at work, stress, anxiety, instability, boredom and procrastination activities.

One of the theories that suggest models to face the conditions of stress is coping. Thus, individuals may use coping strategies that have been defined as a cognitive and behavioral effort conducted to master, reduce or tolerate the internal and external demands. The coping can be divided into two categories: emotion-focused coping and problem-focused coping [4]. In the first category, coping strategies propose mechanisms capable of influencing the emotional part of the individual lowering the level of stress, such as meditation. In the second category strategies seek to eliminate the sources of stress present in the organization, such as the restructuring of a department. Sometimes, it is not possible to eliminate the source of stress. So, in this cases, it is useful the strategies able to lowering the level of stress.

III. Related Work

Technologies that enable user interaction have characteristics that can be used to assist the coping strategies of stress, among which stand out: Augmented Reality (AR), Virtual Reality (VR) and Serious Games (SG). The main characteristics of AR and VR are: immersion, engagement and interaction. Moreover, the solutions using AR combine a 3D visual interface and tracking system for the alignment of real and virtual objects. Recent research also shows the power of gaming technologies to support virtual communities and distributed training groups, to explain concepts and to engage and motivate people.

These technologies have been used in the area of physical rehabilitation and coping with post-traumatic stress. Some papers present AR systems to assist in human rehabilitation. These systems have AR as one of the main technologies used to develop the solution. For example, in [11] is proposed a training environment incorporating AR in a set of devices, developed to extension fingers rehabilitation.

Beyond Augmented Reality, Virtual Reality is used in [12] to describe a solution developed to help patients during the learning phase of the use of upper limb prosthesis, without actually having to use the prosthesis.

Other works propose the use of gaming technology to assist in physical rehabilitation. For example, in [13], it is proposed a game system (NeuroGym) based on biofeedback. This system can be used to improve muscle activation and gait pattern of a patient with spinal cord injury. The training with NeuroGym also improved the balance in a group of older adults.

In [14], it is shown the implementation of a system for capturing full body movement (MoCap), which together with a biosignal acquisition device was incorporated into a game engine. The study authors have implemented a serious game aimed at the rehabilitation of patients with chronic low back pain and neck pain.

It is clear, therefore, that the technologies of AR, VR and SG are being researched to support the recovery process of people who have suffered some kind of trauma. The characteristics of engagement, immersion and motivation mean that they can be used in the development of tools that help people in the recovery process.

On the other hand, surveys conducted so far show that has not been explored technologies AR, VR and SG together, as a whole, as a unique tool to support coping strategies of stress at work. In [15], it is proposed a framework that allows the identification and prediction of stress-generating activities. However, when identified the occurrence of a stress-generating activity, the framework proposes as coping strategies three options: The postponement of the task, a better preparation for the completion of the task or the time to perform some activity that the person considers relaxing. It didn't address the use of technology in coping strategy.

It is presented in [16] a study about the use of games to cope stress at work. This study proved by statistical data that the use of computer and video games are effective in combating stress. However, the research did not propose a systematic way for the use of games in coping stress. Furthermore, the research was done with normal games, or games that are not designed for the purpose of coping stress.

The effectiveness of using casual video games to improve mood and lower the level of stress is also researched and proven in [17]. Some research studying video games as sources of stress and others explore the benefits of games in healthcare in general.

IV. Coping Using Serious Games

We group the researches on occupational stress into a few topics as presented in Fig. 1, namely: Stress Measurement; Observation of Activities Performed; Stress Pattern Identification (stressors); Stress Prevision; Coping Strategies and Evaluation.

The relationship between these topics is also shown in Fig. 1. The stress measurement is made during the observation of the activities performed by the employee in the workplace. This measurement can be made, for example, using sensors or questionnaires for identifying changes biological, physical or behavioral indicating whether or not the person is stressed. After identifying the activities that generate stress (stressors), we can determine pattern activities, enabling the prediction of stress situations. Information got in previous topics can help to develop coping strategies. Further, these strategies can be evaluated to assess its efficiency.

The Occupational Health Psychology researches usually develop studies on the identification of coping strategies within the scope of a profession. It can do the evaluation of the strategies identified or suggested programs of stress management. Some researches propose protocols to measure, to evaluate or to rank the strategies that people adopt to cope stress. The scale COPE [18] is one example of such protocols. It assesses the different ways people respond to stress by means of a set of items classified into eight distinct conceptual dimensions, namely: confrontation, withdrawal, self-control, social support, accepting responsibility, escape-avoidance, problem solving and positive reappraisal.

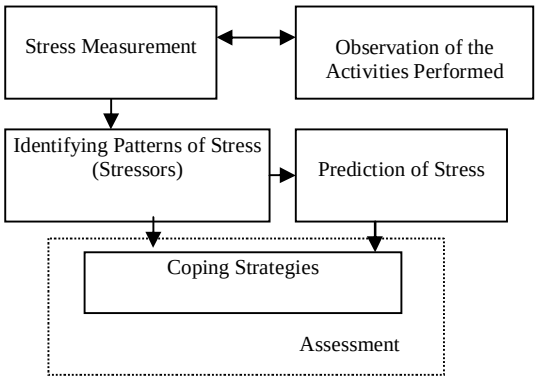


Fig. 1: Occupational Stress Topics of Study

Research in the computer area regarding occupational stress are concentrated on identifying/measuring stress using sensors that capture biological signals, sound, image or behavioral patterns. In addition, some studies, for example, in [16], discuss theoretically the use of games as a coping strategy. Other works, such as in [17], related games as a change agent in mood making the stress level decrease. Although these studies describe the use of games in stress coping we didn't find a strategy that uses some kind of technology, including games, systematically in coping strategies.

Serious Games differ from "normal" games because they have a purpose (specific and intentional learning) to be achieved when a person uses it. Thus, in the development of Serious Games, these goals must be observed to guide its construction.

The purpose of this work is the use of Serious Games with Virtual Reality or Augmented Reality techniques in coping strategies of occupational stress. The proposal also suggests that the Serious Games developed for this purpose should be guided by the dimensions of the COPE scale and the needs of the worker.

Workers' needs must be observed for it to be possible to identify the coping strategies of stress that they practice. Furthermore, it allows the construction of a profile that will help in defining what types of strategies can be effective in coping stress.

The dimensions of the COPE scale provide an orientation of how the game should address the coping stress offered to the player. For example, we can develop a game that takes the player to learn or work confrontation by a way of demonstrating feelings of dissatisfaction with the problem spilling emotions.

Figure 2 shows the proposal scheme. Two distinct periods are presented: Building Moment and Application Moment. The first is the stage where the workers' needs are identified. These needs should be observed in the context of a particular profession to guide the development of Serious Games based on the dimensions of the COPE scale. The second is the stage where the employee is suggested to use the game developed.

The Employee Monitoring, present in Figure 2, is responsible for providing employee information to

identifying stressors and coping strategies. Furthermore, it identifies when the game developed should be suggested to the employee as a tool to reduce stress levels. Thus, the proposed scheme can be part of a control program stress within a company where serious games can be used as a support tool.

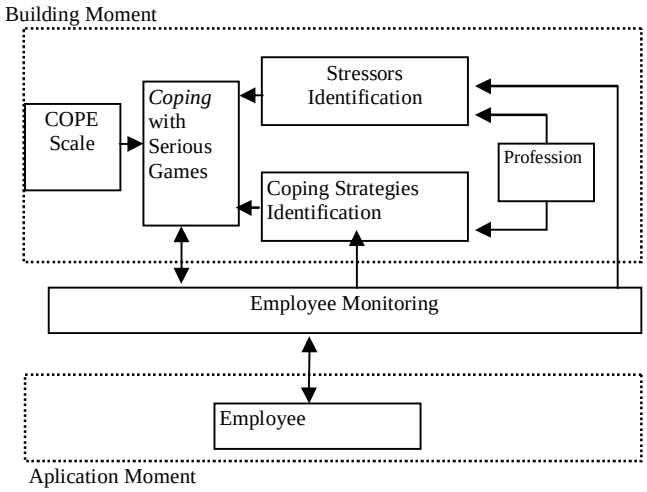


Fig. 2 Using Serious Games as Coping Support

Thus, this proposal takes into account the needs of the employee and directs the development of Serious Games according to the scale of COPE. The choice for the use of the technique of Virtual Reality or Augmented Reality in the construction of Serious Games is determined by the employee profile built in Building Moment.

V. Conclusion

The use of games as an agent capable of reducing the stress levels of a person is proven in several studies. However, concrete proposals that utilize systematically Serious Games with Virtual Reality and/or Augmented Reality techniques developed as the purpose of coping stress in the workplace were not found in the literature. The proposal described in this work, though still embryonic, aims to contribute to research on coping strategies to occupational stress using Serious Games.

The proposed schemes in Fig. 2 present, in high level, the information necessary to develop the Serious Games as a tool to coping occupational stress. An interface, Employee Monitoring, is suggest to help the identification of the moment when is necessary an intervention to decrease the employee stress level.

This scheme needs to be validated and tested to verify their effectiveness and efficiency. However, it is expected that the development of Serious Games oriented by COPE scale using Virtual/Augmented Reality techniques, with the purposed of coping can make them even more efficient as support tools for coping occupational stress.

VI. Acknowledgment

This work was supported by Capes e FAPEMIG projects APQ-02934-11 e PPM-00511-13.

References

[1] P. Paoli, D. Merllié. **Third European survey on working conditions 2000**. European Foundation for improvement of Living and Working Conditions, 2001.

[2] Agência Européia para a Segurança e Saúde no Trabalho: **Stress e riscos psicossociais**. < https://osha.europa.eu/pt/topics/stress >. Acessado em 15/05/2013.

[3] Universidade de Brasília: **UnB Agência, Estresse no trabalho leva mais de 1 milhão de brasileiros a receber auxílio-doença**. 25/04/2011. < http://www.unb.br/noticias/unbagencia/cpmod.php?id=88633 > Acessado em 02/06/2013.

[4] F. N. Moreno, G. P. Gil, M. C. L. Haddad, M. T. O. Vannuchi. **Estratégias e Intervenções no Enfrentamento da Síndrome de Burnout**. Revista de Enfermagem UERJ, Rio de Janeiro, 2011. Pg 140-145.

[5] STRESSLESS, **Projeto**.< http://web.spi.pt/stressless/index_PT.html > Acessado em 20/06/2013.

[6] ISMA-BR **International Stress Management Association** < http://www.ismabrasil.com.br/quem-somos > Acessado em 01/06/2013.

[7] R. M. Cardoso et all. **O Stress nos Professores Portugueses. Estudo do Instituto de prevenção do Stress e Saúde Ocupacional – IPSSO**. Coleção mundo dos saberes 31, Porto: Porto Editora, 2000.

[8] R. Margis, P. Picon, A. F. Cosner, R. O. Silveira. **Relação entre estressores, estresse e ansiedade.** Revista dePsiquiatria, *25*, p. 65-74, 2003.

[9] V. Perkins. **Stress: o ponto de ruptura.** São Paulo: Jovens Médicos, 1995.

[10] S. P. Robbins. **Comportamento organizacional.** Rio de Janeiro: LTC, 2002.

[11] X. Luo, R. V. Kenyon, T. Kline, H. C. Waldinger, D. G. Kamper **An Augmented Reality Training Environment for Post-Stroke Finger Extension Rehabilitation.** In Proceeding of 2005 IEEE 9th International Conference on Rehabilitation Robotics, Chicago, IL, USA, June 28 – July 1, 2005.

[12] E. Lamounier, K, Lopes, A. Cardoso, A. Andrade, A. Soares **On the Use of Virtual and Augmented Reality for Upper Limb Prostheses Training and Simulation.** In 32nd Annual International Conference of the IEEE EMBS Buenos Aires, Argentina, August 31 – September 4, 2010.

[13] E. Hiden, Y. Lojoie, A. Nativ **Games-based biofeedback training applications in rehabilitation and fall prevention.** Virtual Rehabilitation International Conference, *2009* , June 29 2009-July 2 2009.

[14] C. Schonauer. et al. **Chronic Pain Rehabilitation with a Serious Game using Multimodal Input.** In International Conference on Virtual Rehabilitation, Switzerland, June 27 – 29, 2011.

[15] B. Jorn, H. Leszek, K. Rafal, P. Mykola, S. Natalia. **Stess@Work: from measuring stress to its understanding, prediction and handling with**

personalized coaching. In Proceedings of the 2nd ACM SIGHIT International Health Informatics Symposium (IHI '12). ACM, New York, NY, USA, pp. 673-678, 2012.

[16] R. Leonard. **Games and Recovery The Use of Vídeo and Computer Games to Recuperate from Stress and Strain.** in Journal of Media Psychology 2009; vol. 21(3), pp. 126–142, 2009.

[17] C. V. Russoniello, K. O'Brien, J. M. Parks. **The Effectiveness of Casual Vídeo Games in Improving Mood and Decreasing Stress** in Journal of CyberTherapy & Rehabilitation. Spring 2009, vol. 2, Issue 1, 2009.

[18] C. S. Carver, M. F. Scheier, J. K. Weintrau. **Assessing coping strategies: A theoretically based approach.** Journal of Personality ond Social Psychology, vol. 56, pp. 267-283, 1989.

AN INTER-DISCIPLINARY INQUIRY-BASED STEM PROJECT ON DEVELOPMENT OF ANTI-CORROSION

Suzanne Lunsford, Ph.D.
Professor of Chemistry
Department of Chemistry
Wright State University
Dayton, OH 45435, USA

ABSTRACT

Novel STEM (Science Technology Engineering and Mathematics) projects / experiments have been designed to increase the integrated science content, pedagogical, and technological knowledge for real-world applications of our undergraduate students (pre-service teacher science education majors). This study has focused on (1) the fundamental understanding on the relationship of metal oxide films and polymers to prevent corrosion of metal surfaces, and (2) the development of new materials which have the capability for real world applications. Following the inquiry based learning strategy the pre-service undergraduate research students learn to develop and study the metal surfaces utilizing various types of technology. Science Technology Engineering and Mathematics (STEM) Projects are a requirement for our pre-service teacher science education majors at Wright State University and do involve inter-disciplinary subjects. This project on prevention of metal corrosion will be discussed has shown success with engaging not only undergraduate college students but also high school students to solve the real-world research problem of metal corrosion prevention, which involves chemistry, engineering, and electrochemistry. For over two decades there has been an interest in sol-gel coatings and conductive polymers to protect metals (stainless steel). Sol-gel coatings and conductive polymers offer probable benefits over other traditional applications to prevent corrosion. The physical and chemical properties of the metals improve significantly due to various novel sol-gel inorganic coatings and conductive polymers were investigated to determine the effect of the different chemicals sulfuric acid (H_2SO_4), and salt (NaCl) solutions on the surfaces. The project allowed the comparison of titanium dioxide (TiO_2), zirconium dioxide (ZrO_2) and a mixture TiO_2/ZrO_2 sol-gel versus conductive polymers such as poly-3-methylthiophene and poly(2,2'-bithiophene) to prevent corrosion on metals.

The morphology of the metal surfaces was analyzed by such technology as Scanning Electron Microscopy (SEM). SEM allowed the students to determine the optimum sol-gel and optimum polymer material for metal protection, which will be discussed to show the significant research findings and problem-based skills developed. Another set of technology that the students learned to utilize was controlled potential electrolysis (CPE) electrochemical instrumentation to grow conductive polymers on metal surfaces. Overall this STEM project on protective metal coatings has allowed science education students and high school

students (science fair projects) to work on a real research based problem that encouraged more interest in learning science. A questionnaire about science teaching and science instruction for the pre-service undergraduate students (qualitative data) will be shared to show the pre-survey and post-survey results before and after inquiry-based experiences from STEM projects. Overall the survey has shown significant changes in the pre-service students perceptions before and after the STEM projects regarding their ability and comfort in teaching inquiry-based science.

Keywords: Hands-on /Inquiry-based learning, Professional development, Inter-disciplinary science, and Informing via Research.

Inter-disciplinary Inquiry-Based Science Experiences for the 21st Century

Dr. Suzanne Lunsford, Ph.D.
Professor of Chemistry
Department of Chemistry
Wright State University
Dayton, OH 45435, USA
Suzanne.Lunsford@wright.edu

Phuong Khanh Quoc Nguyen
Environmental Science Ph.D. Candidate
Wright State University
Dayton, OH 45435, USA
Nguyen.53@wright.edu

Corrie Spradlin
Department of Chemistry
Wright State University
Dayton, OH 45435, USA
Spradlin.17@wright.edu

ABSTRACT
Inter-disciplinary Inquiry-Based Science Experiences that have Science Technology Engineering and Mathematics (STEM) in the undergraduate learning experiences are the learning experiences needed for the 21st century. The laboratory research experiences for my undergraduate science education students working on development of sensors to analysis of field samples changes a typical traditional classroom into a highly interactive learning environment. The inquiry-based labs are required to engage students into problem solving with the process of critical thinking skills. These problem-based skills enable students to generate, evaluate and share their research findings for their sensors developed. The students are required to design the sensor to analyze a sample collected on a field trip. The sensor(s) developed to the samples collected on a field trip are analyzed by technology such as cyclic voltammetry (CV), differential pulse voltammetry (DPV), square-wave anodic stripping voltammetry (SWASV), Scanning Electron Microscopy (SEM), Fourier Transform Infrared Spectroscopy (FTIR), X-Ray Fluorescence (XRF) and Raman Spectroscopy [1-3]. The results of the SWASV will be shared to show the students success at learning how to utilize and develop novel sensors in this talk related to heavy metal detection in water sampling.

INTRODUCTION:
The traditional laboratory experiments are often isolated and ineffective use of learning time and students can fail to understand the content and relevance of the lab. Also, traditional labs do not allow the integration of different disciplines and various instrumentations into one experiment. The old and typical technique for teaching undergraduate chemistry lab is to have a pre-lab lecture followed by a lab to validate the pre-lab lecture given with limited technology

and instrumentation skills developed. This can be referred to as the cookbook technique for teaching undergraduate students chemistry. Guided inquiry-based methods of teaching are useful and allow students to explore the lab problem and proceed to problem solve the lab with guidance by the teacher. Bodner et al., have suggested that guided inquiry-based learning has allowed students to learn better and be more interested in their chemistry studies. [4] The successes of guided inquiry-based experiences have brought about the inter-disciplinary chemistry lab experiences for our undergraduates at our university. These guided inquiry experiences will engage students into the needed technology of studying and understanding various type of instrumentation utilized from not only chemistry but also the field of environmental science/geology, biology, mathematics and engineering aspects.

GUIDED INQUIRY EXPERIMENT EXAMPLE; DISCUSSION/RESULTS:

One of the latest experiments developed was a guided inquiry-based experiment in the detection of heavy metal detection will be discussed in detail. Detection of heavy metals in the low parts per billion (ppb) concentration levels will be displayed. The most recent news from journals published by the *American Chemical Society* are discussing the need for a novel sensor that can detect low detection limits (ppb) range for heavy metals due to the humanitarian disasters in areas such as China, Bangladesh and Vietnam. Typical detection of heavy metals in water samples are utilizing methods such as chromatography, spectroscopic methods and Inductively Coupled Plasma Mass Spectrometry (ICPMS). However, due to the serious problems with heavy metal poisoning to human life there is the need for on-site sampling, in the field sensors that are portable and easy to utilize unlike the methods such as ICPMS. Therefore, electrochemical sensors are ideal for the detection of the heavy metals since this is an environmental concern and in high concentrations naturally in the soil and water in Asian countries.

The electrochemical technique Square wave anodic stripping voltammetry (SWASV) that is easily portable for real-world analysis and inexpensive as well to detect heavy metals was a guided inquiry based lab recently developed to enhance students' instrumental skills and electrochemistry content. The heavy metals are pre-concentrated on bare electrodes such as gold, silver and carbon electrodes via electrochemical reduction for a specified length of time then the electrochemical stripping from the bare electrodes surface results in the faradaic signal which is used to determine the concentration present. The current due to the heavy metals oxidation is featured as peaks with heights proportional to the concentration of the heavy metal present. The focuses of the lab were determining the optimum electrochemical technique such as cyclic voltammetry or SWASV. Also, the pH level that the optimum value to detect the heavy metals and the SWASV parameters on the bare electrodes such as frequency, amplitude, deposition potential and deposition time were analyzed.

The successes of the students' detection of heavy metal detection at the different bare electrodes by SWASV illustrated such low detection in the ppb range. The pre-and post-tests assessment of the students content

knowledge was an overall gain of n=0.73; which illustrated a high gain according to R.R. Hake method. [5] This lab can be further expanded into more guided inquiry by more in-depth development of the sensor to detect lower than ppb levels of heavy metals in water; down to the ppt levels. This study of the morphological surface of various modified electrodes with polymers to possible sol-gel materials could achieve even lower detection limits (ppt levels) in a real-world analysis sample on site with limited contamination issues of fouling electrode surfaces. Therefore, this lab can be further continued as a guided inquiry experience, which has gained interest of students while engaging their problem solving skills to detect these heavy metals. [6-7] The successes of the electrochemistry experiments in an inquiry-based mode will be shared to show how the 21st learning is vital to meet the needs of todays research endeavors while integrating electrochemistry with technology such as CV and SWASV (BASi-instrumentation).

Acknowledgement: Thanks to Phuong Quoc Nguyen and Corrie Spradlin for their assistance with the lab development at Wright State University. Thanks for Dr. Ted Clark and OSU for contributions to Research Experiences for Undergraduate Learning Experiences as well. Dr. Roger Gilpin from Wright State University for the helpful suggestion to create more labs related to heavy metals detection by electrochemistry techniques.

Keywords: Hands-on/Inquiry-based learning, Professional Development, Inter-disciplinary Science, and Informing via Research.

REFERENCES:

1. M. Hughes, B. Muir, A. Schulte, and S. Lunsford, *The Chemical Educator*, **18**, 152-154 (2013).
2. M. Hughes, B. Muir, and S. Lunsford, *The Chemical Educator*, **18**, 123-125 (2013).
3. Lunsford, S., Hughes, M., and Nguyen, P., *Systemics, Cybernetics, and Informatics, Vol. 11, Number 6, 32-35 (2013).*
4. G.M. Bodner, W.J.F. Hunter, R.S. Lamba, *The Chemical Educator*, **3,** *1-21(1998).*
5. R.R. Hake, *Am. J. Phys.*,**66** (1), 64-74 (1998).
6. Simm, A., Banks, C., and Compton, R., Electroanalysis, ***17***, 1727 (2005).
7. Fosberg, G., O'Laughlin, J.W., Megargle, R.G., *Anal. Chem.*, ***47***,1586 (1975).

Optimizing Ship Classification in the Arctic Ocean: A Case Study of Multi-Disciplinary Problem Solving

Mark Rahmes
Rick Pemble
Kevin Fox
John Delay

Harris Corporation,
Government Communications Systems
Melbourne, Florida 32904

ABSTRACT

We describe a multi-disciplinary system model for determining decision making strategies based upon the ability to perform data mining and pattern discovery utilizing open source actionable information to prepare for specific events or situations from multiple information sources. We focus on combining detection theory with game theory for classifying ships in Arctic Ocean to verify ship reporting. More specifically, detection theory is used to determine probability of deciding if a ship or certain ship class is present or not. We use game theory to fuse information for optimal decision making on ship classification. Hierarchy game theory framework enables complex modeling of data in probabilistic modeling. However, applicability to big data is complicated by the difficulties of inference in complex probabilistic models, and by computational constraints. We provide a framework for fusing sensor inputs to help compare if the information of a ship matches its AIS reporting requirements using mixed probabilities from game theory. Our method can be further applied to optimizing other choke point scenarios where a decision is needed for classification of ground assets or signals. We model impact on decision making on accuracy by adding more parameters or sensors to the decision making process as sensitivity analysis.

Keywords: Game Theory; Detection Theory; Decision Making; Fusion

1. INTRODUCTION

The environment is an important part of the Intelligence Community agenda. The Intelligence Community is involved in this work, and involvement is important for citizens of the United States and the world. The Intelligence Community's job is to ensure that senior policymakers and military commanders have objective information that will allow them to make better decisions. Through collection and analytic effort, intelligence reports give our country's leadership insight into how events in all parts of the world will unfold and how these events will affect our national security. Environmental trends, both natural and man-made, are among the underlying forces that affect a nation's economy, its social stability, its behavior in world markets, and its attitude toward neighbors. The environment is one factor. Environmental degradation, encroaching deserts, erosion, and over farming destroy vast tracts of arable land. This forces people from their homes and creates tensions between ethnic and political groups as competition for scarce resources increases. There is an essential connection between environmental degradation, population growth, and poverty that regional analysts must take into account [2].

National reconnaissance systems that track the movement of tanks through the desert, can, at the same time, track the movement of the desert itself and see the sand closing in on formerly productive fields or hillsides laid bare by deforestation and erosion. Satellite systems allow assessment of the magnitude and severity of damage. Adding this environmental dimension to traditional political, economic, and military analysis enhances the ability to alert policymakers to potential instability, conflict, or human disaster and to identify situations which may draw in American involvement. Some events have already dictated that environmental issues are included in our intelligence agenda. When Moscow initially issued misleading information about the accident at the Chernobyl Nuclear Power Plant, U.S. leaders turned to the Intelligence Community to assess the damage and its impact on the former Soviet Union and neighboring countries [2].

The U.S. Coast Guard's (CG) value to the nation resides in its proven ability to protect those on the sea, protect the United States from threats delivered by sea and protect the sea itself. Its unique authorities, capabilities, competencies and partnerships as a military, law enforcement, regulatory and humanitarian service are central to that value proposition. The CG is recognized worldwide for its ability to execute these diverse maritime missions over vast geographic areas and under the most challenging and demanding conditions [7].

As the CG prepares for the future, the emerging maritime frontier of the Arctic is significantly expanding the operating area. Last September 2013 it was observed that the Arctic had the lowest sea ice extent in recorded history, and there are vast areas of open water where there used to be ice. Activity in the most remote reaches of Alaska continues to evolve and grow, including planned drilling operations in the Chukchi and Beaufort Seas, foreign tankers using the northern sea routes which transit through the Bering Strait and Sea, and small cruise ships pressing even further into the Arctic. As the receding ice invites increased human activity in commercial and private ventures, there is increasing demand for the Coast Guard to

ensure the safety, security and stewardship of the nation's Arctic waters [7].

The circum-Arctic region and Outer Continental Shelf area ranks second behind the Gulf of Mexico for volume of resources. Sovereign and industrial activities will continue to evolve around access to an abundance of resources. These resources include an estimated 13 percent of the world's undiscovered oil, 30 percent of undiscovered gas, and some one trillion dollars worth of minerals including gold, zinc, palladium, nickel, platinum, lead, rare-earth minerals, and gem-quality diamonds. As Arctic ice recedes and maritime activity increases, the Coast Guard must be prepared to administer and inform national objectives over the long-term. The United States is an Arctic nation, and the Coast Guard supports numerous experienced and capable partners in the region. The aim of this strategy is to ensure safe, secure, and environmentally responsible maritime activity in the Arctic. This strategy establishes objectives to meet this aim and support national policy [7].

There are three strategic objectives in the Arctic for the U.S. Coast Guard. Improving Awareness: Coast Guard operations require precise and ongoing awareness of activities in the maritime domain. Maritime awareness in the Arctic is currently restricted due to limited surveillance, monitoring, and information system capabilities. Modernizing Governance: The concept of governance involves institutions, structures of authority, and capabilities necessary to oversee maritime activities while safeguarding national interests. Limited awareness and oversight challenge maritime sovereignty, including the protection of natural resources and control of maritime borders. Broadening Partnerships: Success in the Arctic requires a collective effort across both the public and private sectors. Such a collective effort must be inclusive of domestic regulatory regimes; international collaborative forums such as the Arctic Council, International Maritime Organization (IMO), and Inuit Circumpolar Council; domestic and international partnerships; and local engagements in Arctic communities focusing on training and volunteer service [7].

An oceanic trade route across the Arctic from the North Atlantic to the North Pacific would represent a transformational shift in maritime trade, akin to the opening of the Panama Canal in the early 20th century. An Arctic marine highway would cut existing oceanic transit between Europe and Asia by an estimated 5,000 nautical miles [7].

Economic factors (e.g., unemployment rates, prices for food, such as bread, or fuel), Political factors (freedoms, type of government), Religious factors (type of religions, religious tensions) combined with trend information such as sentiment analysis on social media, open source data, news, etc. can provide indicators of areas undergoing stress or at risk. An attempt to predict the likelihood of reaction to a future event will be based on correct situation analysis. Efforts to combine the information required for these predictions are time consuming and labor intensive. The availability of open source social media information and implementation of artificial intelligence (AI) methodologies makes this problem tractable. Our GlobalSite system, shown in Figure 1, can be used as a method for decision making and reduce cost of analyses.

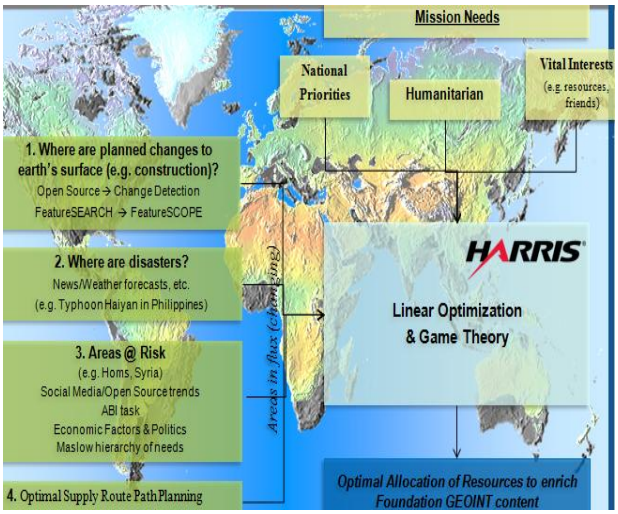


Fig. 1. System Overview

2. ANALYTIC HIERARCHY PROCESS

The Analytic Hierarchy Process (AHP) is a multi-criteria decision-making approach. The AHP is a decision support tool which can be used to solve complex decision problems. The AHP has attracted the interest of many researchers mainly due to the mathematical properties of the method and the fact that the required input data are easy to obtain. It uses a multi-level hierarchical structure of objectives, criteria, sub criteria, and alternatives. The pertinent data are derived by using a set of pair wise comparisons. These comparisons are used to obtain the weights of importance of the decision criteria, and the relative performance measures of the alternatives in terms of each individual decision criterion. If the comparisons are not perfectly consistent, then it provides a mechanism for improving consistency [18].

Hierarchical game theory can be used to solve for the best strategy for decision making in complex problem solving. Hierarchical game theory can determine cooperating capacity between hierarchies and detect the best united strategy. This can provide a powerful method of resource allocation and asset planning in order to maximize a player's response [8]. Figure 2 shows the hierarchical, game structure for our example. All of these hierarchies are part of the overall player's capability to compete with other players. The four hierarchies are: sensors, ship classes, organizations, and competing nations. In our example we can model uncertainty of sensor detection to determining ship classification and model the probability of a nation verifying ship reporting accuracy. This information is then used to compete with other nations or players for situational awareness of the Arctic region. A feedback loop is used to model sequential time periods as updates are observed [14].

This framework solves for controlling ability in groups and the hierarchical trait in command and control. Thus, to enhance independent decision-making in lower decision-makers and make decision-making between the upper and the lower decision-makers not only have clear hierarchies, but also interact and optimize each other. Sequentially, perfect effects can be obtained with a hierarchy model. [8].

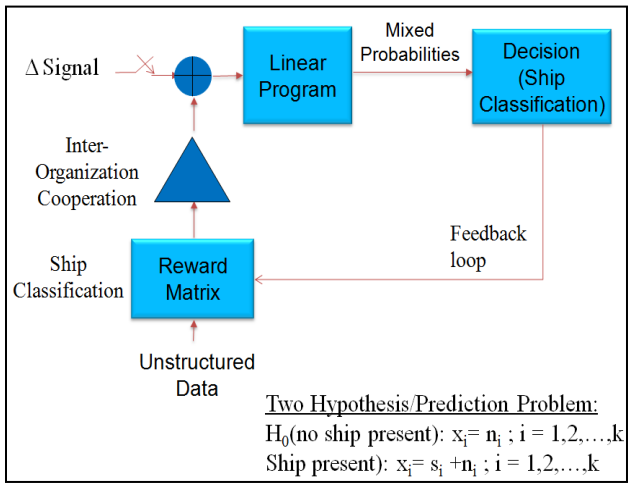


Fig. 2. Model Process Flow

The organizations determine the missions. The missions are to be carried out by the organizations. The sensors are used to carry out the missions. Our example consists of organizations, sensors [5], ship classes, and nation players. Figure 3 shows the elements of each hierarchy.

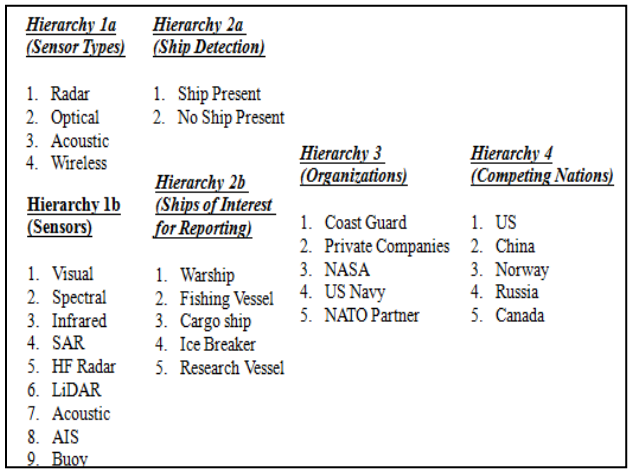


Fig. 3. Hierarchies and Elements

The goal is to maximize the decision function. The overall performance of the decision is based on several levels of hierarchical decisions. Our example starts with the decision to optimize ship classification decision to verify ship reporting accuracy versus other nation players. Cooperation between organizations is modeled using multi-player Prisoner's Dilemma in our solution [10]. The choice of sensor to use is based on availability. The ship classes are based on real world data. Each level of hierarchy has an impact on the overall ability for a country or blue player to compete on a global basis. Cooperation is less likely to emerge in a large group than a small group. The iterated Prisoner's Dilemma (PD) game has been used extensively in the study of cooperative behaviors in social and biological systems. The N player PD game is realistic for modeling the cooperation strategies [22].

However, in the real world, individual rational actions are not always taken. In our example, responsible organizations are given incentives to cooperate so that their action can take a better action in the international game so that the blue player can best compete [19]. Results of an open competition are well explained by cognitive hierarchy (CH). In many games it boils down to predicting how deeply other agents in the game will be reasoning. An agent that does not reason enough risks being exploited by its opponents, while an agent that reasons too much, may not be able to interact productively with its opponents [21].

We let the objective function be $F = (F_1, F_2)$ where F_1 could be the blue player. We let x_1 be the decision maker's choice for blue. We let h_{11} to h_{1m} be the lower hierarchical decision maker's response. The objective function for blue's lower decision makers is f_{ij}. We let S_1 be the feasible sets for variable x_1. S_1 depends on x_1 and h_{11} to h_{mj}. The lower decision-maker can modify the upper decision maker's mind according to the actual status [8].

In our example, there are several resource management stages or hierarchies as shown in Figure 4. These stages include information needs, collection objectives, and observables. Our example serves as a method to enhance situational awareness for making best decisions concerning the status of the Arctic region. Situational awareness is used as critical information for activity based intelligence for decisions for allocating resources. Resource management is a component of situational awareness is to translate the decision maker's information needs to real world actions. The orchestration of sensors and identification of sources to produce relevant input for a fusion process is referred to as resource management. Resources are the technical means employed to gather essential data [9]. Operations Research is a branch of mathematics that studies decision making to obtain the best decision. Game theory can help determine the optimal investment strategy [19].

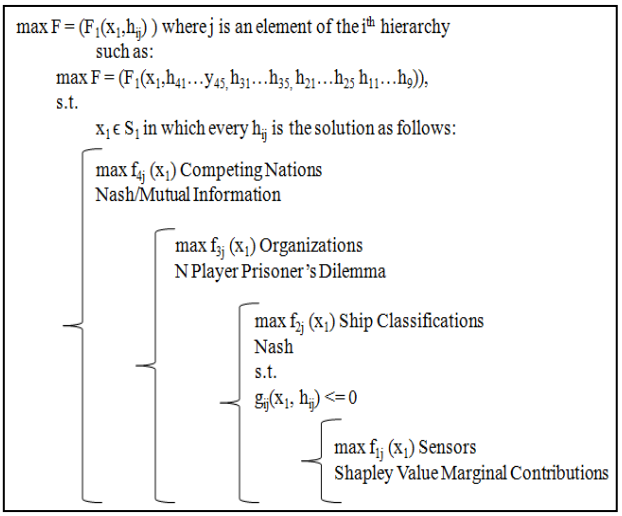


Fig. 4. Hierarchical Structure

Generally, players may not possess full information about their opponents. In particular, players may possess private information that others should take into account when forming expectations about how a player would behave. To analyze these interesting situations, a class of games with incomplete information was created as use case scenarios (i.e., games where at least one player is uncertain about another player's payoff function) which are the analogue of the normal form

games with complete information similar to Bayesian games or static games of incomplete information [17].

Hierarchy game theory offers important insights and demonstrates superiority of cooperation over competition. Game theory models the heuristics people use in managing their conflicts and helps to explain why rational decisions often miss opportunities for mutual gain [12]. Imperfect information may still be useful to help make decisions. Opponent modeling works by observing the opponent's actions and building a model by combining information from a pre-computed equilibrium strategy with the observations [3]. Cognitive hierarchy is important because it predicts the effect of group size which is not predicted by the Nash equilibrium [1].

3. INFORMATION FUSION

Game theory is the study of strategic decision making. It is the study of mathematical models of conflict and cooperation between intelligent rational decision-makers and is often thought of as an interactive decision theory. It has been applied to economics, political science, psychology, logic, biology and other complex issues. Modern game theory began with the idea regarding the existence of mixed-strategy equilibrium in two-person zero-sum games, applied to economics. Later this evolved to provide a theory of expected utility, which allowed mathematicians and economists to treat decision-making with uncertainty. The notion of probabilistic predictions utilizing game theory is critical in practice to many decision making applications because optimizing user experience requires being able to compute the expected utilities of mutually exclusive pieces of data.

We have created a reward matrix of five rows and nine columns. The five rows are the ship classifications as shown in Figure 5. The nine columns are the sensor capabilities values for probability of detection or area under the Receiver Operating Characteristic (ROC) curves (AUC). Other simulations have accounted for games involving more than two players [4]. Determining ship classification which maximizes the a posteriori probability are Nash equilibrium points of the game. The Nash equilibrium points are local maxima have been proven. Relaxation algorithms exist showing efficiency and rapid convergence [8].

	Vis	HS	IR	SAR	HF Radar	LiDAR	Sound	AIS	Buoy
Ship									
No Ship									

	Vis	HS	IR	SAR	HF Radar	LiDAR	Sound	AIS	Buoy
Warship	a11	a12	a13	a14	a15	a16	a17	a18	a19
Fishing Vessel	b21	b22	b23	b24	b25	b26	b27	b28	b29
Cargo Vessel	c31	c32	c33	c34	c35	c36	c37	c38	c39
Ice Breaker	d41	d42	d43	d44	d45	d46	d47	d48	d49
Research Vessel	e51	e52	e53	e54	e55	e56	e57	e58	e59

Fig. 5. Reward Matrix

Maximin equilibrium often is the strategy and is called the Nash theory application of zero or constant sum strategy game [11]. Game theory considers the effect of a player's decision on other decision makers. In many situations, the opponents know the strategy that they are following and what actions are available. The Nash threshold can be used to determine if the player is on the blue or red team. For example, if a reward matrix exists, then the equilibrium point is the one where the reward is the smallest value in its row and the largest number in its column [19].

$$\max_{\text{all rows}} (\text{row min}) = \min_{\text{all columns}} (\text{column max}) \quad (1)$$

This left half of (1) presents the basic applied theory to decision making of our model under uncertainty. For a possible action, one consideration is to choose the "best" worst outcome. The maximin criterion suggests that the decision-maker should choose the alternative which maximizes the minimum payoff he can get. This pessimistic approach implies that the decision-maker should expect the worst to happen. The maximin criterion is concerned with making worst possible outcome as pleasant as possible [19].

The right half of (1) represents minimax regret criterion which uses the concept of opportunity cost to arrive at a decision. The regret of an outcome is the difference between the value of that outcome and the maximum value of all the possible outcomes. For any action and state, there is opportunity of loss or regret. The decision-maker should choose the alternative that minimizes the maximum regret he/she could suffer [19].

Using different weights allowed for choices is to highlight the ability and need for a tool which can be used to allow the user to dial and modify modeled parameters of the reward matrix to model "what if" scenarios. Additionally saving the weights to a file allows for peer review in order to check and validate decisions. Our approach is modeled, so that the process can be repeated to allow for new or higher quality data/information to be inserted into the process to generate updated results [15]. Equation (2) is the translation of a reward matrix to a linear program which can be solved mathematically.

$$\max v \quad (2)$$

s.t.

$$v - a_{11}x1 - b_{21}x2 - c_{31}x3 - d_{41}x4 - e_{51}x5 <= 0$$
$$v - a_{12}x1 - b_{22}x2 - c_{32}x3 - d_{42}x4 - e_{52}x5 <= 0$$
$$v - a_{13}x1 - b_{23}x2 - c_{33}x3 - d_{43}x4 - e_{53}x5 <= 0$$
$$v - a_{14}x1 - b_{24}x2 - c_{34}x3 - d_{44}x4 - e_{54}x5 <= 0$$
$$v - a_{15}x1 - b_{25}x2 - c_{35}x3 - d_{45}x4 - e_{55}x5 <= 0$$
$$v - a_{16}x1 - b_{26}x2 - c_{36}x3 - d_{46}x4 - e_{56}x5 <= 0$$
$$v - a_{17}x1 - b_{27}x2 - c_{37}x3 - d_{47}x4 - e_{57}x5 <= 0$$
$$v - a_{18}x1 - b_{28}x2 - c_{38}x3 - d_{48}x4 - e_{58}x5 <= 0$$
$$v - a_{19}x1 - b_{29}x2 - c_{39}x3 - d_{49}x4 - e_{59}x5 <= 0$$

$$x1 + x2 + x3 + x4 + x5 = 1$$
$$x1, x2, x3, x4, x5 >= 0$$

The initial solution for the blue player's mixed strategy in terms of probabilities: **x** = (x1, x2, x3, x4, x5).

4. MODELING AND SIMULATION

When you use a mathematical model to describe reality you must make approximations. The world is more complicated than the kinds of optimization problems that we are able to solve.

Linearity assumptions usually are significant approximations. Another important approximation comes because you cannot be sure of the data that you put into the model. Your knowledge of the relevant technology may be imprecise, forcing you to approximate values in A, b, or c in a linear equation. Moreover, information may change. Sensitivity analysis is a systematic study of how sensitive solutions are to changes in data [6].

Figure 6 shows our sensitivity analysis using several different signal to noise ratios (SNRs). The graph shows the accuracy as a function of the number of parameters (sensors). In our example we have added a signal to one column parameter and Gaussian noise to each parameter in the reward matrix. The SNR, d, is the distance between the means on the two hypotheses, ship class present or not, with a variance normalized to one.

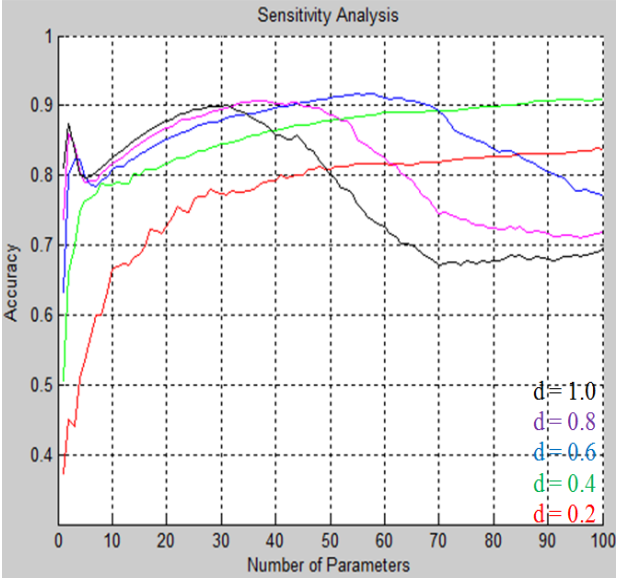


Fig. 6. Linear Programming Sensitivity Analysis

Our sensitivity analysis shows that more parameters are useful when the SNR is low. The analysis also shows that at higher SNR, two or three sensors are enough. The reason for higher accuracy at low SNR is that more information, sensors, helps. The reason for a lower accuracy at higher SNRs is because we have added more constraints as we add more parameters to the linear program. This is similar to principal component analysis where most of the information is contained in the first few variables [13].

If you add a constraint to a problem, two things can happen. Your original solution satisfies the constraint or it doesn't. If it does, then you are finished. If you had a solution before and the solution is still feasible for the new problem, then you must still have a solution. If the original solution does not satisfy the new constraint, then possibly the new problem is infeasible. If not, then there is another solution. The value must go down. (Adding a constraint makes the problem harder to satisfy, so you cannot possibly do better than before). If your original solution satisfies your new constraint, then you can do as well as before. If not, then you will do worse [6].

Figure 7 shows the sensitivity analysis for the Shapley method for calculating accuracy due to marginal contributions based on order [16]. Our Matlab implementation of treating each ship class as a player in a game uses the Shapley value as the probability of choosing a class based on sensor parameters. Our solution currently considers the running average while adding another sensor parameter or column to the reward matrix.

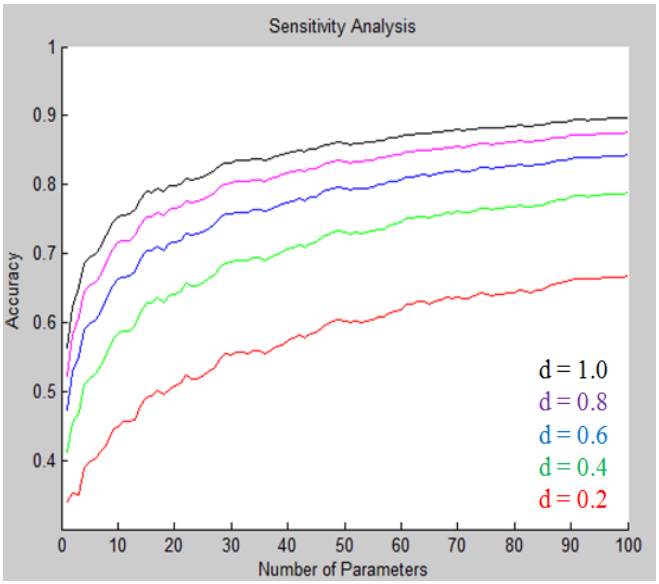


Fig 7. Shapley Sensitivity Analysis

It is interesting to compare the linear programming solution with the Shapley solution. This shows that there is some decision making process for choosing a modeling method. The human brain still needs to be involved in sorting out complex results.

Other work includes an analysis of strategic behavior of countries when there is imperfect verification of an arms control agreement. It provides a framework for determining whether an arms control agreement is desirable, shows which factors are needed for the agreement to be maintained in the absence of third-party enforcers, and develops propositions relating changes in verification capabilities to changes in the likelihood of cheating and the use of verification technology. These propositions yield several paradoxes of information (for example, the better the verification technology, the less often it will be employed). Since the analysis incorporates both simultaneous and sequential moves by the players, it provides new insights into other applied areas as well as game theory [20].

5. CONCLUSION

No decision is ever 100% correct; however, understanding the effects of algorithmic decisions based upon multiple variables, attributes, or factors and strategies with probability assignments can increase the probability for the best decision for a particular situation or event. We discussed a linear programming method for modeling ship verification reporting activities with limited resources. We realize that solution presented is only a guide and is not intended to replace the human brain in decision making. Multi-disciplinary solutions including automated game theory is promising for solving real world strategies and helps an analyst make optimal decisions.

Our contribution in this paper is to combine linear programming, hierarchical game theory with uncertainty modeling in order to plan for activities based on open source intelligence. Our example shows mixed probabilities of ship classification to help a player's situational awareness in order stay knowledgeable about a region of interest. Our solution provides the ability to populate a reward matrix from unstructured big data. We combine a number of technologies for data fusion. Our solution is a multi-use application: course of action planning, resource management, and risk assessment. In the presence of game theory and hierarchical theory, and on the basis of dynamic state attrition-models, our strategy can solve this kind of problem favorably.

Automated processing techniques are needed to augment tactical intelligence-analysis capabilities by identifying and recognizing patterns, weighting them appropriately, providing near real time objective decisions where the user can interact with the information based upon their experiences and knowledge base. GlobalSite is a probabilistic decision solution which allows for users to interact with information in near real time using game theory to provide a reward matrix of best possible outcomes.

Our approach adds computational intelligence to provide the analyst with a decision making capability to reduce time to collect and process data while retaining the information needed to complete the mission analysis. Additionally the probabilities of successfully performing ship reporting verification are filtered by the level of cooperation between participating organizations. Proper execution is critical for attaining the desired impact with respect to other nation players. Our sensitivity analysis models the accuracy as a function of the number of available sensor assets.

6. REFERENCES

[1] Camerer, Colin F., Teck-Hua Ho, and Juin-Kuan Chong. "A Cognitive Hierarchy Theory of One-shot Games." (2002).

[2] Deutch, John. "The environment on the intelligence agenda." *Speech presented to the World Affairs Council.[On-line]. Available:http://www.odci.gov/cia/public_affairs/speeches/archives/ 1996/dci_speech_072596. html* (1996).

[3] Ganzfried, S., and T. Sandholm, "Game theory-based opponent modeling in large imperfect-information games," *International Conference on Autonomous Agents and Multi-Agent Systems (AAMAS)*, 2011.

[4] http://www.innocentive.com/blog/2013/11/25/the-impact-of-crowdsourcing-on-typhoon-haiyan-response/

[5] http://www.arcticresponsetechnology.org/project-updates/oil-spill-detection-and-mapping-in-low-visibility-and-ice/report-on-oil-spill-detection-and-mapping-in-low-visibility-and-ice-surface-remote-sensing

[6] http://econweb.ucsd.edu/~jsobel/172aw02/notes7.pdf

[7] http://www.uscg.mil/seniorleadership/DOCS/CG_Arctic_Strategy.pdf

[8] Li, Zhang, Zhang An, Zhang Yongfang, and Shi Zhifu. "Study on group air to ground attack-defends hierarchical dynamic decision-making." *Journal of Systems Engineering and Electronics* 18, no. 3 (2007): 540-544.

[9] Liggins, Hall, Llinas, "Handbook of Multisensor Data Fusion, Theory, and Practice", 2nd Edition, 2009.

[10] Matsumoto, Mitsutaka. "Formulation and applications of hierarchy games." *International Game Theory Review* 3, no. 02n03 (2001): 189-201.

[11] Nash, John, "Non-Cooperative Games" The Annals of Mathematics 54(2):286-295, 1951.

[12] Picard, Rick, Todd Graves, and Jane Booker, "Stability modeling and game-theoretic considerations," *Los Alamos National Laboratory Technical Report*, 1999.

[13] Pourhomayoun, Mohammad, and Mark L. Fowler. "An SVD approach for data compression in emitter location systems." In *Signals, Systems and Computers, 2011 Conference Record of the Forty Fifth Asilomar Conference on*, pp. 257-261. IEEE, 2011.

[14] Rahmes, M., Hackett, J., Fox, K., Pemble, R., Lemieux, G., Gans, H.," A Cognitive Group Hierarchy Game Theoretic Framework for Bandwidth Management" IEEE CogSIMA 2014 Conference, March 2014.

[15] Rahmes, M., Wilder, K., Yates, H., Fox, K., "Near Real Time Discovery and Conversion of Open Source Information to a Reward Matrix", WMSCI 2013, 12 July 2013.

[16] Shapley, L. S. (1953) A Value for n-person Games, in: ''Contributions to the Theory of Games, II,'' H. Kuhn and A. W. Tucker, eds., Princeton: Princeton University Press.

[17] Slantchev, B., "Game Theory: Static and dynamic games of incomplete information," Dept of Political Science, Univ San Diego, May 15, 2008.

[18] Triantaphyllou, Evangelos, and Stuart H. Mann. "Using the analytic hierarchy process for decision making in engineering applications: some challenges." *International Journal of Industrial Engineering: Applications and Practice* 2.1 (1995): 35-44.

[19] Wayne Winston, Operations Research Applications and Algorithms 4th. Edition, 2003.

[20] Wittman, D., "Arms control verification and other games involving imperfect detection." *The American Political Science Review* (1989): 923-945.

[21] Wunder, Michael, Michael L. Littman, Michael Kaisers, and John Robert Yaros. "A Cognitive Hierarchy Model Applied to the Lemonade Game." In *Interactive Decision Theory and Game Theory*. 2010.

[22] Yao, Xin, and Paul J. Darwen. "An experimental study of N-person iterated prisoner's dilemma games." In *Progress in Evolutionary Computation*, pp. 90-108. Springer Berlin Heidelberg, 1995.

USING ABM TO IMPLEMENT COMPLEXITY THINKING IN LOGISTICS – THOUGHTS AND EXPERIENCES

Fredrik Nilsson

Division of Packaging Logistics, Department of Design Sciences,
Lund University. Sölvegatan 26, P.O. Box 118, 221 00 Lund, Sweden
E-mail: fredrik.nilsson@plog.lth.se, Tel: +46 (0)46 222 91 55; Fax: +46 (0)46 222 80 60

ABSTRACT

The aim of this paper is to discuss the implications of a complexity approach to the management of logistics operations. The research is a result of the need for managers of logistics operation to be able to adapt to the ever changing demands of their context and customer demands. The identified emphasis of mechanistic assumptions in traditional modeling of logistics is discussed and it is suggested that a change towards adaptive approaches, models and tools is needed. This means that the models have to be able to consider self-organization and emergent phenomena. Furthermore, the paper aims to provide valuable insights into how ABM can be an implementation tool for a new way of thinking in organizations i.e. based on complexity principles.

What is proposed in this paper is a new approach for logistics management based on an extensive set of assumptions which are more suited to real-life logistics operations, i.e. where considerations are taken to the socio-technological processes involved. An extensive set of assumptions means that those of linearity, reductionism, determinism, rationality etc. dominating the logistics discipline are still apparent and useful; however, they are of limited use when it comes to logistics operations involving several people, functions, and processes, where the situation is characterized by conflicting demands and multiple goals. Instead, assumptions of nonlinearity, heterogeneity, subjective and bounded rationality, self-organization, emergence, subjectivism, to mention but a few, are central to the complexity approach and highly apparent in real-life logistics operations.

The paper centers around insights gained from a combined case and simulation study of a fast-moving consumer goods (FMCG) company in Sweden, which has customers in all Nordic countries and is part of a major global FMCG company. There was a debate among the different functions in the company concerning how to keep total costs low while at the same time increase the level of customer service. The debate focused particularly on costs in inventory versus the costs in production, and on how their forecast reports influenced the actual results concerning on-time-in-full deliveries and production efficiency i.e. set-up times, batch sizes etc.

In order to gain insights into the different scenarios which the managers in the company provided arguments for, an agent-based model was developed. Several agents were identified and designed to represent the operations. These were inventory, production planning, planning system, ten production lines, and three markets. Several interviews were conducted with managers responsible for logistics (in-bound, out-bound), supply chain management, operations planning, production, and inventory. In addition, observation was carried out in order to examine the daily behavior of the people involved in the actual activities performed within the company. At the same time quantitative data was gathered from all

functions and put into the database for the model. Data from January 1st - March 21st 2004 was put into the model. The reason why this period was chosen was primarily that it had been a quite stable period and there was sufficient data available to verify the results.

Before any simulations began the model was verified. The verification process was divided into two parts: a qualitative verification and a quantitative verification. The purpose of the qualitative verification was to check the individual agent's behavior while the purpose of the quantitative verification was to make sure that the agent's interactions create a reasonable result. The verification process helped to guarantee that company employees involved felt confident that the model actually worked. At the same time, the complexity approach was communicated and aligned to the behaviors in the qualitative verification and the results from the quantitative verification. The output of the model resulted in several scenarios which were discussed and evaluated by the management team involved. One outcome of specific interest was the scenario where improvements of change times between products and running speed would not leverage any significant benefits to the total cost while changes in planning behavior, from planning four ahead to two days would result in much more accurate deliveries and lower inventory levels. Table 1 provides the result of two simulation runs where two different policy changes were tested and evaluated from a company perspective.

For the managers involved, results, such as the ones described in table 1, provided new insights into how to approach changes in different parts of the company. However, even more importantly, during the process of developing the model, the complexity approach gave the managers a new reference frame for discussing and improving business performance. They had to understand each other's perspectives and real-life operations i.e. how production set-up times were set, how the planning was done, what the costs were for full inventory levels etc.

Table 1. Results from two scenarios

	Reference scenario	Scenario 1	Scenario 2
No. of products in stock	4000	3900	4300
Service levels	-	+ 0,8 %	+ 1.6 %
Production utility	68%	+ 5 %	- 0.5 %
Total cost	-	+ $650000	+ $30000

Conclusively, in this paper it is argued that the current, common logistics theories and methods cannot mirror the real-life operations logistics managers confront. It has been proposed that by considering more complexity in models constructed insights can be gained concerning system-wide effects of logistics systems and the major effects minor occurrences or changes in behaviors can have on costs as well as performance.

In order to move towards increased adaptivity in logistics management it is the conclusion that two major efforts need to be taken. First of all, a theoretical framework is needed that is in line with assumptions align to real-life experience by managers i.e. of a less mechanical character, with emphasis on adaptation and change. In this article, the complexity approach has been proposed and applied in the logistics context with success. The aim with the complexity approach has been to increase the understanding and the insights concerning how to handle complexity and uncertainty and eventually catalyst for logistics managers in their actions i.e. provide an aid for a change in mind-set. Based on several interviews with both logistics managers as well as logistics researchers the complexity approach is agreed on to be useful and quite importantly, it mirrors well the experiences both managers and researchers have experienced.

Secondly, in order to "implement" the complexity approach and provide tangible results in a, from a management perspective

reasonable short time it has been concluded that ABM provides a good applicable method and tool. The cases reported in this paper, based on extensive simulations of the logistics operations show interesting results and provide beneficial insights for the people involved i.e. not only logistics managers but as well other managers in different functions of the case companies.

It is also concluded that the complexity approach with ABM as the application provides a useful and beneficial approach for the understanding of system wide effects. This means that managers using the complexity approach will increase their understanding of how decisions can sometimes escalate into both positive and negative outcomes of high magnitude, and sometimes diminish and consequently have no effect at all on business performance. Further research will focus on research concerning interorganizational activities, i.e. extending the case to include suppliers and customers. By doing this increased understanding may be gained concerning the effects at one supplier might affect the down stream operations at the customers.

Keywords: Complexity theory, operations management, simulation, supply chain management.

Arabic irregular verbs: inflection and derivation for English-Arabic Machine Translation

Mohammed Mahmoud Abu Shquier
Department of IT, University of Tabuk
Tabuk, 41791, KSA

ABSTRACT

Irregular verbs can be defined as verbs that act differently from the basic patterns in all or some cases; those verbs may act irregularly in the derived forms as well, irregular verbs pose a challenge to Machine Translation (MT) in particular; morphological and syntactical analysis, the definition of irregular verbs involves accounting doubled, hamzated and weak verbs. This paper is presenting work-in-progress to build rule based machine translation with lexical properties and characteristics to handle Arabic irregular verbs agreement in English-Arabic MT. Arabic lexicon would be supported with a strong theoretical framework and implemented using robust tools that will facilitate its implementation. in this paper we built a module to detect irregular verbs, i.e, doubled, hamzated, mithal, hollow, defective, and enfolding. A set of rules have been conducted based on the tense of the verb, place of the vowel root-letter, (i.e., first, second or third person representation), number, gender, tense and mood features, Our proposed module has been effectively evaluated using real test data and achieved satisfactory results.

Keywords: MT, agreement, irregular-verbs, hamzated, doubled, hollow, defective, word-ordering, perfective, imperfective..

1. INTRODUCTION

Arabic verbs are constructed on a root that uses three consonants or radical latters which is known as (Morphological balance) ($C_1aC_2aC_3a$)[1] [2] فعل - This non-concatenative way used in this paper is typically called root and pattern morphology - to identify the basic meaning of the verb. However, the inflection of verbs in Arabic is mainly achieved through the use of prefixes and suffixes denoting person, number, gender, case, mood and tense.

The major two categories of verbal structures in Arabic are the perfective and the imperfective. The imperfective is used for both the simple present and simple future tenses to denote an unfinished act which is still in progress, while the perfective is used for the simple past tense, however, the perfective verbs indicate a completed act.

Arabic imperfective verbs have five moods as shown in figure 1. four of which (the indicative, subjunctive, jussive, and energetic) share one structure but with different endings. The fifth mood, the imperative, has its own distinct structure.

There are Seven morpho-syntactic features involved in the agreement of Arabic irregular verbs: number (singular, dual and plural), gender (feminine and masculine), person (1st 2nd, and 3rd), case (nominative, accusative and genitive), definiteness (definite and indefinite), mood (indicative, imperative, subjunctive, jussive and energetic) and tense (perfect, imperfect and participle) as shown in figure 1. [12].

According to (Wightwick, J and Gaafar M., 2008) Weak verbs are the largest category of irregular verbs. They can be subdivided into four types depending on which of the root letters is affected:

- Verbs with waaw or yaa' as the first root letter (Mithal verbs).
- Verbs with waaw or yaa' as the second root letter (Hollow verbs).
- Verbs with waaw or yaa' as the third root letter (Defective verbs).
- verbs that have two weak letters in their roots (Enfolding verbs).

[1] The reference that we have used as sources of data is related to the Arabic Morphological Balance: Al Rajihi (1993), Wright (1967), Al-Hamalawi (1991), Omer et. al. (1984), Yaqub(1988), Makram (1987), Al-Dahdah (1991), Al-duqur (1986), and Mustafa et. al. (1989).

[2] To clarify the structure of Morphological forms we have used the corresponding CV array of each form alongside. C_{ns} corresponds to radical letters, and represent the consonants of فعل

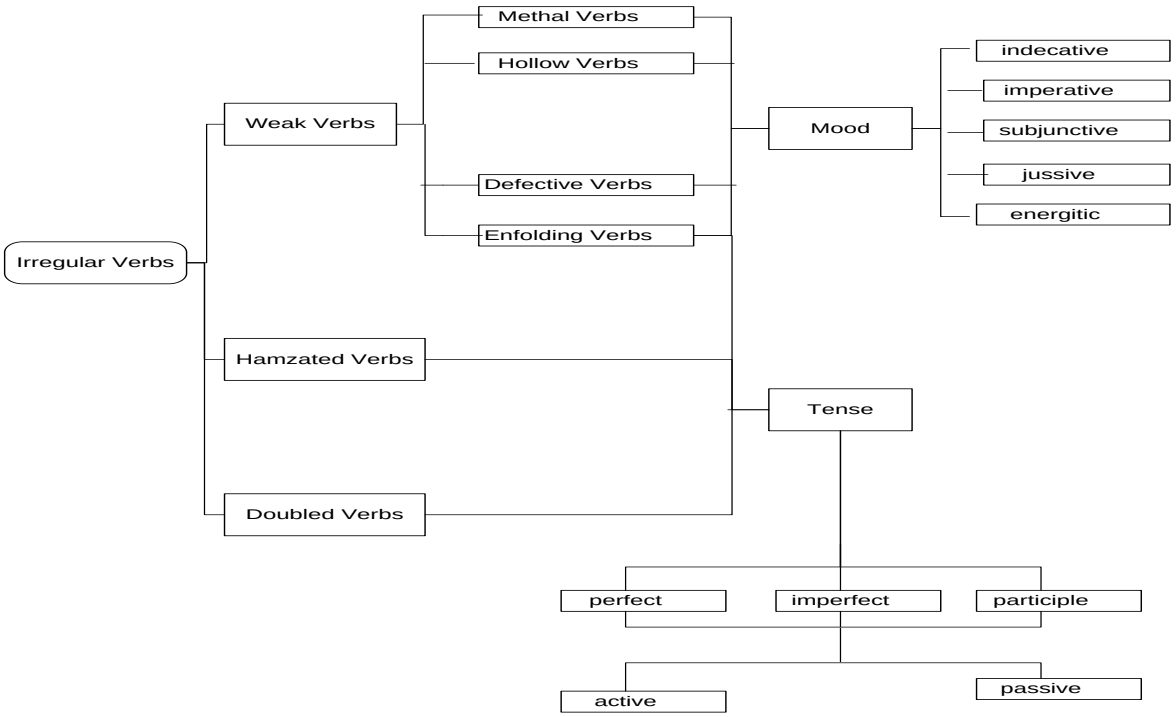


Figure 1. Arabic irregular verbs with their conjugation dependences

2. REVIEW OF LITERATURE

Arabic is the fourth most widely spoken language in the world. It is a highly inflectional language, with a rich morphology, relatively free word order, and two types of sentences [2][3].

Verbs in Arabic are categorized in different ways according to the needs of the grammarians or applications. Verbs can be classified depending on the number of characters that form their root, or depending on the nature of characters forming their root as this will influence their conjugation and the forms of their derivations [6].

Verbs can be further sub-categorized by tense (past, present and future), case (nominative, accusative and genitive), with respect to transitivity (intransitive and transitive), aspect (perfective, imperfective and imperative), with respect to the subject (person, number and gender) and, voice (active and passive).

Corbett (2001) defined agreement as "systematic covariance between a semantic or formal property of one element and a formal property of another.", he used the terms "controller" to refer to the element which determines the agreement, "target" to refer to the element whose form is determined by agreement, and "domain" to refer to the syntactic environment in which agreement occurs [15][24][31].

Attia (2008) stated that Arabic has rich agreement morphology which allows it to show agreement relations between various elements in the sentence.

Essentially, the Arabic word can be described as follows:

[prefix1][prefix1] stem [infixes] [suffix1] [suffix2] [1], table 1 below shows some examples of the affixes handling.

Table 1. an Arabic affixes/suffixes examples.

suffixes2	suffixes1	infixes	stem	Prefixes2	prefixes1	Arabic word	Structure
-	-	-	ضرب	-	-	ضرب	$C_1aC_2aC_3a$
-	-	-	ضرب	يـ	-	يضرب	$yaC_1C_2iC_3u$
-	-	ا	ضرب	يـ	-	يضارب	$yuC_1AC_2iC_3u$
هم	-	-	ضرب	يـ	-	يضربهم	$yaC_1C_2iC_3uhum$
هم	-	-	ضرب	يـ	س	سيضربهم	$syaC_1C_2iC_3uhum$
هم	-	ا	ضرب	يـ	س	سيضاربهم	$syuC_1AC_2iC_3uhum$
هم	ون	ا	ضرب	يـ	س	سيضاربونهم	$syuC_1AC_2iC_3unahum$

Suffixes in Arabic can be categorized into two basic forms, the suffixes that are attached to the verbs and the suffixes that are added to the nouns [32]. Furthermore, some of the suffixes can be attached to both the noun and verb stem. Nevertheless, Arabic permits the use of up to three suffixes simultaneously to be attached to the end of the same stem [1]. Furthermore, Arabic words are built from roots rather than stems and involve diacritization. Written Arabic

is also characterized by the inconsistent and irregular use of punctuation marks [16]. Table 2 below presents a wide range of suffixes example for the verb hit (ضرب).

Table 2. Arabic suffixes examples (adopted from Abu Shquier. M and Abu Shqeer. O 2012) [6]

Suffix	Suffix description	Suffix category Verb/Noun/Both	Example	phonetics
ني	First person	Verb	ضربني	drbny
ك	Second	Both	ضربك	drbk
هـ	Third person	Both	ضربه	drbh
ها	Third person	Both	ضربها	drbha
هم	Third person	Both	ضربهم	drbhm
هن	Third person	Both	ضربهن	drbhn
هما	Third person	Both	ضربهما	drbhma
كم	Second	Both	ضربكم	drbkm
كن	Second	Both	ضربكن	drbkn
كما	Second	Both	ضربكما	drbkma

3. LINGUISTICS

Arabic language plays a crucial role with the root ($C_1aC_2aC_3a$) to add subtle variations to the meaning. There are nine significant derived forms categorized into four groups (for the singular masculine 3rd person in the present tense) as shown in table 3 below:

Table 3. Nine significant derived forms

Group #	Form #	Structure	Arabic imperfect	Arabic perfect
Group I	Form I	$yaC_1C_2aC_3$	يفعَل	فعل
Group II	Form II	$yuC_1aC_2C_2iC_3$	يفَعِّل	فعّل
	Form III	$yuC_1aC_2iC_3$	يُفاعِل	فاعل
	Form IV	$yuC_1C_2iC_3$	يُفعِل	فعل
Group III	Form V	$ytaC_1aC_2C_2aC_3$	يَتَفَعّل	تفعّل
	Form VI	$ytaC_1AC_2aC_3$	يَتفاعَل	تفاعل
Group IV	Form VII	$yanC_1aC_2iC_3$	يَنفَعِل	انفعل
	Form VIII	$yaC_1taC_2iC_3$	يَفتَعِل	افتعل
	Form X	$ystaC_1C_2iC_3$	يَستَفعِل	استفعل

- Forms II and IV can have the meaning of carrying out an action to someone/something else.
- Forms II and IV are making the verb transitive or causative.
- Form II can also give a verb the meaning of doing something intensively and/or repeatedly.
- Form III often carries the meaning of "doing something with someone else": or the meaning of "trying to do something".
- Form V is often the reflexive of form II.
- Form VII is relatively uncommon and usually has a passive meaning.
- Form VIII is a common form and is usually intransitive, these verbs are often close to the basic root meaning.
- Form X often has the meaning of asking for something.

4. DISCUSSION AND APPROACH

The proposed approach will examine the basic verbal forms of Arabic and determine which parts are determined by what. A fully inflected form of an Arabic verb may consist of prefixes, a stem and suffixes/postfixes. The suffixes are person and number agreement features while the prefixes depend on conjunctions. The stem is consisted of arrangements of consonants and vowels that indicate the root, the tense and the mood.

The following is an explanation of the model processes with an example:

Process 1: *Receives the source text (English statement), and pass it to the parser;*

(The girls saw the paper).

Process 2: *Identifies POS by consulting the English grammar database table:*

(The/DT girls/NNS saw/VBD the/DT paper/NN).

Process 3: *Retrieves Arabic meanings as well as subject features from the English lexicon database table;*

(The/ ال *girls/* بنات *saw/* رأت *the/* ال *paper/* ورقة*);*

(girls/ plural, feminine, and 3rd person).

Process 4: *detect irregular verbs based on their categories.*

Process 5*: analyze subject-verb conjugations and apply rules to handle the derivation and inflection of Arabic irregular verbs (process is carried out with the help of a bi-lingual dictionary)*

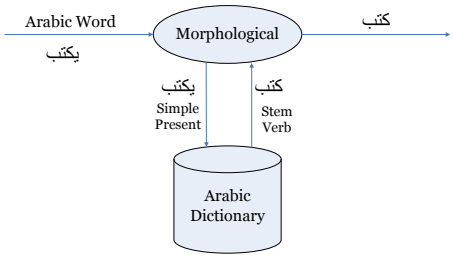


Figure 2. Morphological Analysis with process 5

Process 6: *Analyzes the source text semantically to decide whether SVO should be used or not;*
(The result will be either yes or no).

Process 7: *Creates the correct derivation of the equivalent Arabic regular verbs depending on the results*

from processes 3 and 4, and the consultation of the Arabic grammar, Arabic lexicon.

Process 8: *Creates the correct derivation of the equivalent Arabic irregular verbs depending on the result of the 30 cases shown in the figure below and from processes 3 and 4, and the consultation of the Arabic grammar, Arabic lexicon.*

(If the result of process 4 is no, then the verb will be رَأت (C1aC2at) since the default mode VSO will be used; if the result is yes, the verb will be رأينَ (C1aC2aC3na) since SVO mode will be used).

Process 9: *Finally, the complete Arabic translation is produces by referencing the words ordering rules database table:*

The Arabic generator will synthesis the inflected Arabic word-form based on the morphological features to produce the surface Arabic target language

(based on the result of the previous processes, we will get either رأت البنات الورقة "ra?at albnat alwaraqah" in the case of using VSO or البنات رأينَ الورقة"albnat ra?aina alwaraqah" in the other case SVO).

5. RESULTS AND DISCUSSION

An experiment is conducted on 171 independent test suites based on the following aspects of agreement and ordering of irregular verbs:

1. Article-Noun Agreement.
2. Adjective-Noun Agreement.
3. Verb-Subject Agreement.
4. Demonstrative-Noun Agreement.
5. Relative Pronoun-Antecedent Agreement.
6. Predicate-Subject Agreement.
7. Order of the adjective.
8. Successive words form an expression.
9. Translation of a preposition.
10. Conjunction with "and
11. Adding the preposition " ال".
12. addition and deletion.

After we classified the problems that cause that ill-agreement and ordering of Arabic irregular verbs we then compare between the output of three available systems and compare the output with the original translation of the input text based on those twelve problems. The result of the experiment is shown in the following table.

Table 4. Experiment results

No.	ALKAFI	GOOGLE	TARJIM	Our System
Percentage	92.1%	84.6%	94.2	96.1%

Some of the output of the three systems investigated here is found to give full coherent meaning, and in some cases grammatically correct, translations in general have a problem in one or more aspects. Incoherent translations seem to be produced due to some fault or deficiency in one (or more) phase or component of the analysis of irregular verbs.

5. CONCLUSIONS

This paper has dealt with irregular verb derivation in English-Arabic Machine Translation in conjugation with sentence word order. Through this paper we have explored the characteristics of Arabic language that will affect the development of a Machine Translation (MT). Several distinguishing features of Arabic pertinent to irregular verbs have been explored in detail with reference to some potential difficulties that they might present.

Our proposed module has been effectively evaluated using real test data and achieved satisfactory results. We concluded that we can enhance the output quality of English-Arabic MT by feeding the system with adequate, robust and completed rules to deal with the morph-syntactic inflectional morphological features of irregular verbs. To achieve this task we proposed a set of 30 rules based on the tense of the verb, place of the vowel root letter, first, second or third person representation, number and gender features, and diacritics preceding vowel letter, i.e., nominative, accusative or genitive case.

Through the investigation of the available MTs and related researches, as well as the flexibility of Arabic language grammars, we concluded that we are a bit far away from getting an English-Arabic MT up to the accuracy of human translation due to either faulty analysis of the SL text or faulty generation of the TL text.

6. REFERENCES

[1] Abu-Ata B., "An Arabic stemming algorithm on ERA for information retrieval", PhD. Thesis, Universiti Kebangsaan Malaysia, 2001.

[2] Abu Shqeer O., "Handling Agreement and Word Reordering in English to Arabic Machine Translation", Master Thesis submitted to University of Sains Malaysia, 2002.

[3] Abu Shquier M. and Sembok T., "Word Agreement and ordering In English-Arabic machine translation", Proceeding of the International Symposium on Information Technology, 2008.

[4] Abu Shquier, M. & Abu Shqeer, O. (2012). Words ordering and corresponding verb-subject agreements in English-Arabic machine translation: Hybrid-based approach. International Journal of Soft Computing And Software Engineering (JSCSE), 49-60.

[5] Al-Dahdah, A. 1985. Arabic Language Grammar Dictionary. " معجم قواعد اللغة العربية".Beirut: Lebanon. Lebanon Library.

[6] Al-Fedaghi, S.S., & Al-Sadoun, H.B. 1990. Morphological Compression of Arabic Text. Information Processing & Management. 26(2): 303-316.

[7] Al-Najem, S., Inheritance-based Approach to Arabic Verbal Root-and-Pattern Morphology

[8] Al-Jarf R., "SVO Word Order Errors in English-Arabic Translation", Translators' Journal, vol. 52, 2007, p. 299-308, 2007

[9] Al-Khuli, M., (1982): Al-Taraakeeb al-ahaa?i9a fi llugha al-Arabiyya (Common Structures in Arabic), Dar Al-Uloom Publishing Co.

[10] Al-Momani, I. 2010. Does The VP Node Exist In Modern Standard Arabic? Journal of Language and Literature, ISSN: 2078-0303, May, 2010.

[11] Anderson, Stephen and Sandra Chung. 1977. On grammatical relations and clause structure in verb initial languages. In Grammatical Relations: Syntax and Semantics 8, eds. Peter Cole and Jerrold Sadock. 1-25. New York: Academic Press.

[12] Attia M., 2008. "Handling Arabic Morphological and Syntactic Ambiguity within the LFG Framework with a View to Machine Translation", PhD Thesis, University of Manchester. Faculty of Humanities.

[13] Badawi, E., Carter, M.G. & Gully, A. (2004). *Modern Written Arabic: A Comprehensive Grammar*. New York: Routledge.

[14] Belkredim., F. a. (2009). An Ontology Based Formalism for the Arabic Language Using Verbs and their Derivatives. Communications of the IBIMA Volume 11. ISSN: 1943-7765.

[15] Corbett G. "Agreement: Terms and boundaries. In William Griffin", The Role of Agreement in Natural Language, Proceedings of Texas Linguistic Society Conference, Austin, Texas, 2001.

[16] El-Sadany T., and Hashish M., "An Arabic morphological system". IBM Systems Journal 28 (4): 600-612., 1989.

[17] Feras Saeed. 2010 Word Order and Agreement Asymmetry (English and Foreign Languages University, Hyderabad). The 5th annual Moscow Student conference on Linguistics

[18] Hatem A. and Omer N., "Syntactic Reordering for Arabic- English Phrase-Based Machine Translation", 2010.

[19] Hendrick, R., 2000. Celtic initials. In The Syntax of Verb-Initial Languages, eds. Andrew Carnie and Eithne Guilfoyle. 13-38. Oxford: Oxford University Press.

[20] K., R. (2005). Reference Grammar of Modern Standard Arabic. Cambridge University Press, New York, USA.

[21] Kramer, R. (2009), VSO and SVO word order in Middle Egyptian. In Afroasiatic Studies in Memory of Robert Hetzron, ed. C. Häberl. Cambridge: Cambridge Scholars Press. 92-147.

[22] Mohammad, M.A., 2000. Word Order, Agreement and Pronominalization in Standard and Palestinian Arabic. Amsterdam: John Benjamins.

[23] Ryding K., "A Reference Grammar of Modern Standard Arabic. Cambridge": Cambridge University Press, 2005

[24] Saliba B., and Al-Dannan A., "Automatic morphological analysis of Arabic: a study of content word analysis", Proc. of the First Kuwait Computer conference. pp. 231-243., 1990.

[25] Shaalan, K. (2005). Arabic GramCheck: A grammar. Software Practice and Experience, John Wiley & sons Ltd.,, 35(7):643-665.

[26] Shaalan. K., a. A. (2009). Syntactic Generation of Arabic in Interlingua-based Machine Translation Framework. Third Workshop on Computational Approaches to Arabic Script-based Languages.

[27] Sharif, M. (1993): Al-Tarakeeb al-naHwiyya (Grammatical Structures), Al-Shabaab Bookstore Publishing.

[28] Sproat, Richard. 1985. Welsh syntax and VSO structure. Natural Language and Linguistic Theory 3: 173-216.

[29] Wightwick, J. & Gaffar, M. (2008). Arabic Verbs and Essintials of Grammar. New York: McGraw-Hill.

[30] Wickens G., "Arabic Grammar", Cambridge: Cambridge University Press, 1980.

[31] Woolford, Ellen. 1991. VP-Internal Subjects in VSO and nonconfigurational languages. Linguistic Inquiry 22: 503-540.

[32] Yusif J., "Automatic Part Of Speech Tagger for Arabic Language using Neural Network". PhD Thesis submitted to National University of Malaysia, 2007.

The Way of No-Way To Pursue Knowledge in Many Ways

Jayanta Choudhury
Technology Researcher, TeamQuest Corporation
Clear Lake, Iowa, 50401
jayanta.choudhury@teamquest.com,
jayanta.choudhury@gmail.com

Abstract

"The Tao that can be told is not the eternal Tao.
The name that can be named is not the eternal name.
The nameless is the beginning of heaven and earth.
The named is the mother of ten thousand things.
Ever desireless, one can see the mystery.
Ever desiring, one can see the manifestations.
These two spring from the same source but differ in name; this appears as darkness.
Darkness within darkness.
The gate to all mystery."–Lao Tsu (B.C. 2500)

The above is an English translation of the first verse of the book "Tao Te Ching" by Lao Tsu. A working meaning of the word "Tao" is "way". The technical jargon "multidisciplinary research" or "interdisciplinary research" are research in many named established areas (i.e. chemistry, physics, sociology, mathematics, statistics, theology, philosophy, political science etc.) by an individual or a group of individuals. This type of research has a mysterious common theme that cannot be isolated but is present in the manifestations in various research disciplines. One example of a common theme can be the goal of a new technological innovation. In this article, the problems and solutions of such endeavors are identified by practical analogies of living and nonliving natural phenomena to the above quoted verse by Lao Tsu.

Keywords: Multidisciplinary, Interdisciplinary, Research, Communication, Calculus

1. INTRODUCTION

The question of relevance of the verse [1] in the abstract must be burning in the minds of the reader. It will become clear in the rest of the article, that the purpose of imparting knowledge is to induce questions in the mind of the student. True knowledge cannot be expressed in words without distorting the knowledge by the combination of words with limited scope. So, the questions will be asked and an effort will be made to enable to find a personal answer by the reader.

Some barriers to pursue knowledge involving skills in several different established areas of research or "Multi Disciplinary Research", during the interactive sessions of International Conference on Education, Training and Informatics (ICETI) 2014, were mentioned. They can be categorized broadly in four types. One, communication problems due to different interpretations associated with same terms in different areas of research. As an example, the word "cell" in biology has a different interpretation than "cell" in mobile-network. Two, ideological rigidity among the research community of any specific established research area. A hypothetical example will be the head of the department of political science not agreeing to hear a proposal of a faculty member to do research to model the change in the political behavior of a population using laws of physics, used for modeling diffusion of heat in liquids based on various environmental conditions, which will involve researchers from the department of physics. Three, phobia of losing relevance. An example will be an extension of the previous example. The experts of the established means of predicting population behavior for political ideology perceiving the new approach as a threat to their future progress in their profession. Four, weakness of human character. Factors like professional jealousy or greed for more power etc.

Serious researchers, innovators and inventors are feeling stifled by these factors in various institutes of academia and industry. The solution seems to have two major themes. One is communication and the other is attitude. In the most peripheral level, the communications meant for multidisciplinary audience have to be clear about the intended meaning of the terms used by the communicator. The communication also has to be balanced to avoid provoking the audience to react in a way which might result into barriers, such as ideological rejection or phobia of losing relevance. The communication also has to be motivating and inspiring to drive people away from their narrow vices of greed, jealousy, arrogance etc. The intangible attitude of the speaker is manifested through the communication to shape the intangible attitude of the audience. This will create a cycle of communication and attitude for effective interdisciplinary research.

In the next section, some simple choices for an effective communication for the purpose of facilitating multidisciplinary research are discussed. Some esoteric aspects of communication to describe vague concepts are discussed by drawing examples and analogies from calculus and physics. In the next section, natural substance like water, philosophical concepts like, acting without acting and the practice of body movement [2] are discussed to understand how to overcome the frustration when barriers are faced by sincere researchers in pursuit of knowledge in multidisci-

plinary research areas. There after, some elaborative examples are mentioned to make a holistic understanding of the verse quoted in the abstract. In the next section, some historical and philosophical aspects of religion is discussed to imply possible source of knowledge that can be applied to manage problems faced by researcher of multidisciplinary areas.

2. COMMUNICATION OPTIONS

Prof. David J. Waters has emphasized the importance of writing research articles jargon free. It is an innate nature of any research area to coin terms for expressing specific concepts and ideas that appear very often in the discussion. Sometimes, even a term with vague meaning in original language is jargonized and very strict meaning is associated. One such example is the word "limit" in mathematics. A person not trained in the discipline of mathematics will not know that a limit may exist or it may not exist in the context of mathematics. This is wildly confusing to people, not trained in the discipline of rigorous mathematics. So, the option here is to pick words that are not hijacked and remoulded by any research discipline.

To eliminate any potential misunderstanding, it is better to use words that highlight the potential for growth and mutual benefit instead of highlighting the mistakes and errors in the solutions found in the confinements of disciplines. For example, words like 'I', 'me', 'my', 'you' should be avoided and replace them by 'we' to share both credit and blame. The simple and plain truth that no body is perfect is thus practiced to make it easy for people to forgive and embrace change.

3. COMMUNICATION OF VAGUE

Prof. David J. Waters also highlighted that the truth is vague and words are definitive and crisp in meaning. Expressing the vague truth by words with crisp meaning is inherently faulty. This motivates towards ways to express the vague better without restricting the expanse of vague truth by meshing it into collection of words with crisp meaning to manifest it in the medium of language.

An example in calculus is analyzed to gain some knowledge about the art of expressing vague truth with words without restricting the actual expanse of vague truths. The term 'limit' in calculus can be explained by looking at a series of numbers such as $\{1, \frac{1}{2}, \frac{1}{3}, ...\}$. If the acceptable numbers are only positive real numbers then a large number produces a very small number (i.e. $1 \div$a positive real number) in the series. Notice that the positive real numbers don't include zero as a member of the collection. Also, notice that the difference between 1 and $\frac{1}{2}$ is greater than the difference between $\frac{1}{2}$ and $\frac{1}{3}$ and so on. The numbers in the series get close to each other as they get smaller. The number which has the infinitely many series members as its nearest neighbor or the center of the infinite concentration of members is called the 'limit' of the series. The formal definition is "a number L is a limit in a set of numbers if for any positive number, δ, there exists a number a in the set, such that $|L - a|$ is less than δ." In the definition, the smallness of δ is most important but not explicitly mentioned. For a very small δ the probability of an exception increases (i.e., absence of a point between two points, δ distance apart if any violation exists). The formal definition includes all possibility but not crisply quantifying the value of δ. It embodies infinitely many points near the limit point by expressing the definition using the vagueness of δ. So, words with vagueness in meaning is used to express a vague concept. If the set of numbers of the series does not include zero as a member then the definition of limit is alluding to an esoteric or vague truth that doesn't exist in the collection.

In physics, soon after Albert Einstein's theory of relativity was published and the results of Michaelson and Morley's famous experiment to detect ether was inconclusive, majority of physicists decided to settle with the concept that space is empty. Recent experimental discoveries in particle physics and high energy physics are driving theoretical physicists to propose concepts of nature of space as container of events of particles appearing and disappearing or particles are being created and destroyed [3]. Notice the vagueness of "appearing and disappearing" without any measurable time of existence.

4. INTEGRATION OF ATTITUDE

Phrases such as "acting without acting", "unblemished witness" and "be like water" [2] have profound guidance about how to solve the problems of multidisciplinary research. Words that lack abstract meaning but have a physical association such as "water" or "air" are free from being moulded into a different meaning by any discipline. Combinations of words contradicting each other, such as "acting without acting", do not allow to arrive into any crisp meaning. I will make an attempt to induce a state of mind to enable independent analysis of the reader. The most vague concept so far is the first verse of Lao Tsu quoted in the abstract.

First, a researcher must be inquisitive and ask what does water have to do with "acting without acting" or "unblemished witness"? The name water has many nameless implications. Water is transparent, it has no color of its own. If water is pure without any particles interfering with lights then it is an "unblemished witness" of its existence. Water flows effortlessly if the surrounding imbalance of gravity makes it do so. It does so until it reaches a point of balance of gravity. Also, it takes the shape of container holding it. This is analogous to "acting without acting". It appears that the water is acting when it flows or changes shape, but in reality it is executing a balancing act in response to the imbalance of gravity of the surroundings. The actions of water are not of the water itself but are manifestations of hidden potentials of the surrounding.

If water is not disturbed then its presence will not be felt. So, the truth of existence of water can be known only by disturbance in water in the form of waves. So, the mani-

festation of waves is not the true nature of water, but rather a hint of existence of water and partial truth of its nature. Similarly words used to express truth are discrete distortions of the continuous truth, but without words no knowledge of truth is possible.

The above description implies an attitude as well. A work of research can be understood by others only up to a level, allowed by their cognitive ability. Research is an effort in pursuit of knowledge. The effort is always flowing towards lack of knowledge. Unless the surrounding presents a lack of knowledge, research will not flow (just because one individual researcher has founds a potential sinkhole underneath). The researcher has to either wait for the sinkhole to open or use "plan B" (mentioned during the interactive session, "Moving beyond traditional academic scholarship: obstacles and ideas"), and start digging to open the sinkhole under the knowledge surface so that the research can flow. The right attitude is to keep up the effort by executing "plan B" with the goal of flow of "plan A." The analogy also implies that greed, jealousy or other vices of individuals cannot hold against true research effort when the environment is ready for it; as a mighty body of water will swiftly wash away all obstacles in a flood or great fall. So, it is better to leave the way for greater research if any individual vice is obstructing the flow of real research, otherwise the flow will buildup and one day the obstacles will be flown over, no matter how big of a dam the obstacles may pose.

Practical application of this paradigm in the practice of martial arts implies that the correct balance of the body (so that the moves are the results of the circumstances presented by the opponent). If any movement of the body leads to slight off-balance, it will give an opportunity to the opponent to use gravity against the person. For example, a proper stance is pre-requisite before a hand strike using the center of the body to generate the force of the strike, so that the body's center of gravity is within the limits of the two legs while the center of the body swings from distance to near of the target (creating the force by change of momentum of the body) to release the force through hand at the time of contact between the hand and the target of the strike. If the swing is not controlled properly, then the body's posture will become weak and the gravity will work against the person and diminish the power of the strike. The same way a researcher should not push the edge too far prematurely, which might give opportunity to detractors to destroy the research by raising question about lack of experimental evidence (or other data to support the hypothesis).

5. CONNECTING THE DOTS

The stage is ready now to connect "water" with the first verse of Lao Tsu, quoted in the abstract. The first four lines of the verse, e.g.,

"The Tao that can be told is not the eternal Tao.
The name that can be named is not the eternal name.
The nameless is the beginning of heaven and earth.
The named is the mother of ten thousand things."

imply that as many different shapes and sizes and motions of waves do not express the total nature of water, similarly no word can express any truth in its entirety; or even the key truth of the universe or the true way of our existence. If seen through a water surface, disturbed with waves, the perceived truth is a distorted truth. Similarly, truth that is expressed through words and names can mean many distorted version of partial truth or ten thousand versions of partial truth, ten thousand being a metaphor for many. An undisturbed water surface is the beginning of elevations and depressions in the form of waves. Similarly, the nameless is the beginning of heaven and earth (or the waves of partial truth and lies).

The next four lines of the verse, e.g.,

"Ever desireless, one can see the mystery.
Ever desiring, one can see the manifestations.
These two spring from the same source but differ in name;
this appears as darkness."

imply that desires only create distorted manifestations, in the same way as greed, jealousy and other vices create a distorted view of good virtues among individuals. Desireless or "unblemished witnessing" will lead to true understanding of what otherwise appears mystery. The manifestation of distorted truth turns the actual truth into a mystery when the truth is viewed in a state of desiring. A desireless state, like that of undisturbed body of water, removes the distortions and without distortion there is no mystery about the truth. Hence "the two spring from the same source but differs in name". The understanding in a state of desiring is lacking in truth and is implied by "this appears as darkness".

The last two sentences of the verse, e.g.,

"Darkness within darkness.
The gate to all mystery."

is more esoteric in nature. One tangible example that I can think of is when eyes are closed it creates a darkness. When the thoughts are stopped then the darkness within darkness is reached. When a body of water is without waves then it is first darkness but the actual truth is at the bottom of the water which is darkness within darkness. Thus in knowing any truth the mind has to be stopped from producing thoughts as thoughts triggering emotions will distort the truth.

Note that the same word "darkness" is used with different meaning in three different contexts. This emphasizes the fact that contradictory connotations are put in a way that, the words are used to trigger the mind to start pondering.

6. HIDDEN HOPE

The problems faced by the researchers pursuing multidisciplinary research are very old. Since ancient times, religious sects have persecuted one another. Religion is a discipline in pursuit of understanding of the truth about existence and meaning of life. The Taoists follow the tenets of Lao Tsu and the book, "Tao Te Ching". The verse quoted in the abstract has similarity in meaning to some verses and teachings of the holy Bible.

The first verse of Genesis in the old testament says, e.g.,

"In the beginning God created the heaven and the earth'.'

In the first verse of "Tao Te Ching", this is almost exactly the same, e.g.,

"The nameless is the beginning of heaven and earth."

The word "nameless" in the verse of Lao Tsu is replaced by "God" in the verse of Genesis. Jesus had said, e.g.,

"Those who have eyes will see and those who have ears will hear."

This means that the literal words that Jesus spoke and the physical body of Jesus were not the complete truth, as Jesus was not speaking to blind and deaf people. Also, Jesus was aware that his words will be spread by word of mouth and will be heard by people who were not present at the time he said the words. So, he was implying the truth cannot be found in the words and pictures. This complies with the verse of Lao Tsu, that the "The Tao that can be told is not the eternal Tao." If one attains a level of expertise, where the truth can be experienced, only then will one know the real 'I' in the verse, e.g.,

"I am the way, and the truth, and the life; no one comes to the Father but through Me."
"I am the gate; whoever enters through me will be saved. They will come in and go out, and find pasture."

If the true Jesus could not be seen by physical eyes or could not be heard by physical ears then one had to experience Jesus (without physical eyes and ears). The word "the way" (or "Tao" in Chinese) along with "the truth" and "the life" are expressing manifestation of the same. "The Life" is a deeper existence as a person can be revived by CPR and other means even if heart had stopped for a while. That means that all the parameters, used to indicate alive, are just manifestation of life and not the whole life itself. Could it really mean that simply by making sounds in the gross physical world to expresses the name "Jesus" one can be transferd to the source of existence (e.g. "the Father"), when Jesus said that one has to pass "through" "the way, and the truth, and the life". If "the life" is so subtle then how is it possible to pass through "the life" by making ripples in the gross physical world? Could it be that Jesus is implying that one has to experience a state of "the way, and the truth, and the life" (e.g., like a body of undisturbed water) to reach the source (e.g., "the Father")? Is it then much different than the verse of Lao Tsu, emphasizing the need to be "ever desireless" (e.g., like the state of a body of undisturbed water), and to be able to "see the mystery" (e.g., reach "the Father")?

The similarities should not be surprising. The common theme of every religion is the truth beyond words and subjective opinion. The confusion of the words not only lead to distortion of truth but to rivalry and war. The history of religious wars holds the lessons for managing the problems faced by researchers in pursuing multidisciplinary research. In general, humankind has become more tolerant of foreign religious beliefs . In the same way, it will be easier to do multidisciplinary research in future if sincere effort continues.

7. CONCLUSION

In the spirit of the first verse of Lao Tsu, this article is not the whole truth but is a finite effort to express the vague and infinite truth by using words that embody vagueness. The various sections in the article are approaching the truth from various crisp aspects. In some cases, both problems and solutions are found as inseparable in their vagueness. At a very refined level, the notion of the problem itself is the problem. Removal of the notion of problem removes the notion of solution, leaving only the pure truth. Thus acceptance of a state of being as a valid state of being is the best solution. This will lead to act like water to find a course through the various potentials of the state of existence without a need to identify problems in the state and force changes in the state as a solution. The forced changes will potentially induce unintended changes in the state, resulting into a polluted solution. This concept can be abused if not understood in the correct spirit. One has to empty the mind of any thought like, e.g., a body of undisturbed water (before even considering this notion). Until then we have to strive towards the actual truth with all honesty and sincerity.

REFERENCES

[1] Gia-Fu Feng, J. English, **Lao Tsu-Tao Te Ching: A New Translation,** Vintage Books Edition, New York, Random House Inc., ISBN 039471833, 1972.

[2] G. Hepker, **A Glimpse of Heaven: The Philosophy of True Health,** CreateSpace Independent Publishing Platform. ISBN-10: 1463687125, ISBN-13:978-1463687120, 2011.

[3] H. Nikolic "QFT as pilot-wave theory of particle creation and destruction", ArXiv, available `http://arxiv.org/pdf/0904.2287v5.pdf`, 2009.

On the Criticality of Interdisciplinary Communications for Continued Scholarly Research, and the Potential Applicability of the Case Studies Methodology

Reflection Paper

Jeffrey A. DUNNE, Ph.D.
Johns Hopkins University, Applied Physics Laboratory
Baltimore, Maryland, USA

ABSTRACT

Increasing the prevalence and effectiveness of interdisciplinary communication/collaboration is not a simple matter, but has significant benefits to offer. Ironically, one of the greatest challenges, namely the diversity in perspectives and contributor nature, provides one of its most significant payoffs. Diversity in backgrounds, skills, knowledge, and approaches promotes ingenuity and creativity, and is a powerful source of innovation. But perhaps more importantly, effective interdisciplinary collaboration is essential for applying forefront research to the most challenging societal problems.

This reflection paper describes a line of reasoning for why effective interdisciplinary collaboration skills have emerged as an essential, and yet largely neglected, requirement for maintaining the development and relevance of scholarly research. It outlines challenges that must be overcome in meeting this requirement, important factors for addressing those challenges, and concludes by discussing the applicability of the case methodology, as introduced at the 2014 International Multi-Conference on Complexity, Informatics and Cybernetics, as a mechanism for training people to become effective participants in interdisciplinary endeavors.

INTRODUCTION: INTERDISCIPLINARY EFFECTIVENESS – AN UNAVOIDABLE FRONTIER

A mere few hundred years ago the landscape of scholarly investigation differed substantively from today's research arena. The research workforce comprised a comparatively small core of dedicated, and typically self-sufficient, intelligentsia undertaking studies directed primarily by their broad-ranging personal interests and curiosities. Most of the "A-list" researchers were able to remain aware of, if not directly leverage and influence, the activities and discoveries of their peers. They might not have described themselves as "multi-disciplinary", as there was no pressing need to draw explicit delineations between individual disciplines, but the essence of research was to make contributions to, and to take advantage of, a holistic body of human knowledge and understanding.

While the past few centuries may be brief on a timeline of human history, the exponential nature of population and knowledge expansion make it a distant past when viewed down the axes of investment and growth, and those intervening ages have witnessed a distinct shift in the nature of scholarly investigation. Today it is essentially impossible for a single person to be well-versed in a holistic body of human knowledge. New discoveries emerge with such rapidity that even the fastest reader cannot keep pace with publications in a large single discipline, much less across multiple fields.

This transition to a discipline-based structure of research has enabled us to continue expanding the knowledge envelope, but has simultaneously introduced a disjunction between product and purpose. While we continue to expand understanding with comparatively minor impedance resulting from this hyper-specialization, the majority of challenging, naturally-occurring problems (i.e. the problems that exist and challenge us in and of themselves as opposed to domain-specific, academic questions arising primarily from intellectual curiosity) remain interdisciplinary in nature. In other words, while our problem-solving toolset has become reductionistic by necessity, our biggest, most critical challenges demand holistic solutions.

As a consequence of this evolution of the scholarly landscape, we face now the challenge of effective knowledge integration on a large scale. What early intelligentsia could address through personal dedication and thoroughness, we must overcome through effectiveness in tailored interdisciplinary collaboration. The purpose of this paper is to reflect upon the critical (and sometimes uncomfortable) challenges that must be faced in training the development of interdisciplinary effectiveness, and is concluded by outlining a mechanism, inspired through discussions held at the 2014 International Multi-Conference on Complexity, Informatics and Cybernetics (IMCIC 2014), that could

serve as one of many tools for contributing to a comprehensive solution.

THE CHALLENGES: LINING UP THE USUAL SUSPECTS

Effective interdisciplinary collaboration requires creativity and informed reasoning to build appropriate connections between different fields of expertise. While this is not a trivial demand in and of itself, it is often dwarfed by the challenge of establishing effective communication between experts in different domains. Where the effectiveness of the former can typically be estimated or measured outright, formulaic mechanisms do not exist to determine whether effective communication has occurred; most often, failure to communicate is only discovered standing over the metaphorical debris from the collision of multiple trains of thought that were not, as it turned out, heading in the same direction after all.

The difficulty in establishing effective communication is not surprising, and is the result of numerous factors. Humans' use of language is contextual, and the interpretation of words is generally subconscious – unless great care is taken to make it deliberate. Even though people may speak the same "language" in the sense of using a common grammatical structure and recognized vocabulary, there can be no guarantee that what is spoken is identical in precise meaning, inference, and consequence as that which is heard. In fact, it can be argued from a logical perspective that because no two people share identical experience bases, perfect communication is essentially impossible for non-trivial topics (but fortunately *effective* communication is more approachable). That this phenomenon appears so frequently as a theme in movies, books, television, etc. is an indicator of the ubiquity of the experience of miscommunication.

Fields of scholarly pursuit establish their own tailored vocabularies in order to support efficient "internal" discourse on important topics, and learning this vocabulary – perhaps one of the most valuable outcomes of a graduate school experience – takes an investment of time, an understanding of context, and a deep appreciation of the domain. Learning more than one domain has traditionally happened only serendipitously, namely when someone just happens to be sufficiently interested in both to warrant the dual investment. While there are certainly individuals who have developed a talent at quickly "picking up local lingos" and are capable of serving as a translator between two fields, this author is not familiar with any program of formal training designed to teach people how to quickly and effectively learn the necessary context and linguistic idiosyncrasies of a domain (i.e. without following the "full immersion" path). Lacking such training, as well as recognition of its value within research communities, we are fundamentally limited in the extent and effectiveness with which we will be able to carry out interdisciplinary work. There are simply not enough "multi-hatted" facilitators out there.

The complexity of domain-specific concepts is not the only reason why learning a field's language can be difficult. Many professionals have come to use their domain's language as a form of "testing ground", a means by which to identify others who have made similar levels of investment as themselves. The domain expert eventually comes to use sophisticated, often obfuscating, terminology as a matter of habit, even when an idea could be explained simply using more common phrases. In effect, there can arise in some experts an elitist attitude, even a desire to make one's own field sound more impressive with the aim of cultivating respect or awe in others. Unfortunately, this often engenders an "us versus them" mindset, making interdisciplinary communication that much more challenging.

A last practical challenge worth noting is that the use of tailored language is a human norm. We use language as we do because it provides us with an efficient means for capturing and expressing concepts, enabling us to manage "large" quantities of complex ideas easily. When we are forced to rely upon verbosity for precision, we find it slow and painful, and the mind is inclined to conveniently forget that everyone else does not share its own "common" knowledge, perspectives, and contexts. As an example, it is common for even experienced public speakers to fail to notice their own use of acronyms during a presentation. The mind does not process or utilize language on a word-by-word basis, and attempting to do so is not a trivial undertaking. Exacerbated by the ever increasing pressure to "do more faster" (and with fewer resources), any solution that even hints at – much less requires – slowing down a little will find itself disadvantaged.

THE SOLUTIONS: ADDRESSING THE CHALLENGES

Breaking interdisciplinary barriers begins with mutual respect. While this sounds obvious, or perhaps even trivial, it is often a significant hurdle. After making a multi-year, if not life-long, investment in a particular domain, that vested interest can easily impact one's perspective of the relative value of other fields. Even at the undergraduate level, it is not uncommon to hear students suggesting that other areas of study are "not real majors" or that their classmates in those majors are not as smart, dedicated, capable, etc. Most people would agree, at least when discussing the matter abstractly over a cup of tea, that cognitive capacities are non-transitive by nature, but this is something easily forgotten in practice. Recognition that intelligence is not a one-size-fits-all linear metric become especially difficult to retain when

multiple researchers are competing for a limit pool of research funds.

Engendering respect is neither fast nor easy. Respect for something or someone results from a body of experiences that lead one to conclude that there is sufficient value to be found against the cost of "excavating" that value. As such, a natural first step is to arrange for circumstances optimized for recognizing the value that others can bring to the table; further, one must continue to do so over an extended period of time in order to repeatedly emphasize the point. It is proposed, then, that a process for building interdisciplinary collaboration should 1) *ensure that differing domains are easily recognizable as having valuable information and skillsets to offer*, and 2) *involve repeated experiences in which those values are apparent*. These two points are important but not sufficient to provide an effective interdisciplinary collaboration training experience, and additional factors will be added in the following paragraphs.

Because bridging a discipline gap is not a natural inclination, it is unlikely to occur spontaneously for most people. Consequently, building an interdisciplinary capability/skill set will require a clearly-identified, and ideally mandatory, purpose as motivation. To be most effective, this purpose should be structured around a specific, concrete problem or challenge that can serve as a focal point for activities and provide tangible success indicators, preferably ones that support metrics highlighting the benefit of interdisciplinary collaboration. Towards this end, the best challenge would be one for which a single discipline is incapable of providing an acceptable solution. At the same time, the problem must be sufficiently complex that contributors do not feel like they are being scripted towards an obvious final solution, i.e. there should be a spectrum of approaches through which the nature and specific strengths of individual participants impact potential solutions. In short, an interdisciplinary communications training activity should have additional solution-space factors of: 3) *providing a shared context with a commonly understood, interdisciplinary problem to be addressed*, where 4) *the problem itself is sufficiently complex that the generated solutions are clearly dependent upon the individual contributors*. Further, 5) *the problem should support multiple viable solutions*, and 6) *have clearly definable measures of goodness to support the ranking of solution quality against the effectiveness of interdisciplinary collaboration*.

There are other considerations that are generically applicable to cultivating an effective communications skill development environment, whether interdisciplinary or otherwise. When groups of people interact, differences in personalities and communication styles can, if left unmediated, result in a less than ideal exchange. To avoid having a subset dominate an interaction, one should aim to 7) *provide a moderated environment with clear rules and expectations to ensure effective and balanced contributions from all participants*. In addition, the best learning and skill development will happen when participants are comfortable and have a clear understanding of expectations. Consequently, one should also strive to 8) *establish a safe environment in which participants have a chance to practice contributing, and preferably are already familiar with the rest of the contributors*.

SUMMARY: AN OPPORTUNITY TO LEVERAGE THE CASE STUDY METHODOLOGY

During the IMCIC 2014, Professor Gill gave a presentation on Case Studies and Methodologies in which he described a process where students were introduced to complex, challenging situations, and trained through a series of activities to use critical thinking to provide useful analyses and recommendations on these situations. Some of the key features of the described method were the selection of an appropriate real-world situation with sufficient complexity that there was not an apparent "right answer"; the extensive collection of context-establishing facts to serve as the basis for discussions and analyses; a well-defined process to prepare students to engage effectively in those discussions/analyses; and a proven mechanism for assessing the extent and quality of contributions made by the participants.

Within that context, consider the list of eight factors that were highlighted in the previous section. Specifically, in developing a system/process for training effective interdisciplinary communication one should:

1) Ensure that differing domains are easily recognizable as having valuable information and skill sets to offer.
2) Involve repeated experiences in which the value of interdisciplinary collaboration is apparent.
3) Provide a shared context with a commonly understood, interdisciplinary problem to be addressed.
4) Use a problem sufficiently complex that the generated solutions are clearly dependent upon the individual contributors.
5) Identify a problem that supports multiple viable solutions.
6) Have clearly definable measures of goodness to support the ranking of solution quality against the effectiveness of interdisciplinary collaboration.
7) Provide a moderated environment with clear rules and expectations to ensure effective and balanced contributions from all participants.
8) Establish a safe environment in which participants have a chance to practice contributing, and preferably are already familiar with the rest of the contributors.

While the original context of the case methodology focused on analysis of business-specific problems, with some slight modifications the same approach could meet

many, if not all, of these eight needs, and hence serve as a valuable tool for training effectiveness in interdisciplinary communications.

A logical starting point for making these adaptations would be the identification of a suitably interdisciplinary problem to address. Specifically, the problem would be one where the information and approaches specific to individual disciplines can be divided amongst different participants, and where a suboptimal outcome would result in the absence of effective communication amongst everyone. Problems of this nature are certainly plentiful, although finding simple, approachable ones would require careful consideration. For example, although cyber security is a fundamentally interdisciplinary topic – balancing monetary and societal risks against financial constraints, technical feasibility, human behavior, corporate drivers, etc. – it might not represent an ideal context for training purposes due to its extreme complexity (and seeming intractability).

In addition to dividing the relevant case facts among the various participants from different fields, a distributed scoring system that emphasizes the value of collaborative solutions could also be advantageous. For example, a non-linear system that results in better scores for cohesive solutions, as well as substantially penalized scores for solutions that disregard inputs/drivers/ requirements from one or more areas, could provide encouragement to ensure that sufficient effort is placed on understanding and meeting the needs of each individual discipline.

It is beyond the scope of this reflection paper to provide a detailed plan for developing a curriculum for training effective interdisciplinary communication, but hopefully the lines of thinking presented herein are compelling for anticipating that the case studies methodology would serve as an effective foundation for such an activity.

INTERDISCIPLINARY PROGRAM FOR IN-SERVICE TEACHERS; WORKING WITH INDUSTRY AND UNIVERSITY TO ENHANCE LEARNING EXPERIENCES IN THE STATE OF OHIO

Suzanne Lunsford, Ph.D.
Professor of Chemistry
Department of Chemistry
Wright State University
Dayton, OH 45435, USA

And

William Slattery, Ph.D.,
Professor of Earth and Environmental Sciences and College of Education
Department of Earth and Environmental Sciences and College of Education
Wright State University
Dayton, OH 45435, USA

ABSTRACT:

Science Teaching for Ohio's New Economy (STONE) is an interdisciplinary professional development program that in-service teachers grades K-12 that experience the integration of earth and physical science in an inquiry-based field. There are various field trips to various industrial settings that teach how geoscientist works in the aggregate industry. During the academic year there is a support system where the industry and the in-service teachers engage their students into real world industrial applications in the aggregate industry. This paper will discuss the utilization of high – tech instrumentation such as X-Ray Fluorescence and Scanning Electron Microscopy to teach real-world science applications of concern.
Pre- and Post-test assessments as addressed by R.R. Hake have shown that these inquiry-based professional development workshops that integrated academia with industry as a positive outcome for our students in Ohio.

Keywords: Hands-on /Inquiry-based learning, Professional development, Inter-disciplinary science, and Informing via Research.

INTRODUCTION:

Colleges and universities, whether large or small, public or private, well or poorly funded are all wrestling with the challenge of integrating an interdisciplinary experience between the university setting and the industrial setting [1]. These interdisciplinary experiences between university and industrial for our in-service teachers are vital to meet the state standards of teaching. One of our programs that address the interdisciplinary learning aspects for our graduate level in-service teachers is called "Science Teaching for Ohio's New Economy (STONE).

The key interdisciplinary aspects of this STONE program are working with the following organizations: OAIMA (Ohio Aggregates and Industrial Minerals Association), Barrett Paving Materials, Shelly Company, Ohio State Core

Repository, Caesar Creek Park, Columbus Limestone Quarry, Enon Sand and Gravel Aggregate Plant, Cemex, Sauls Seismic, Ohio Environmental Protection Association and Bowser-Morner Industry. These in-service teachers that visited all of these industrial settings were enlightened on the administration, structure and complexities of the aggregate industry. These field experiences provided the in-service teachers participating in STONE with the career opportunities for their own students and how to prepare students for these career options in the aggregate industry.

This interdisciplinary program between our university and industry had assisted in-service teachers in the state of Ohio to learn about the aggregate industry. These learning experiences are expanding to their students during the academic year as well while meeting the state standards to integrate math and science content together. The STONE features the following:

1) A summer professional development program for in-service teachers to visit and work with industry. These summer experiences are expanded with their students during the academic year.
2) A role for industry personnel in classrooms and laboratories during the academic year. Additionally, field trips are a vital part of these collaborations between industry and academia.
3) A new model for industry-college – K-12 (in-service teachers) to utilize novel instrumentation such as X-Ray Fluorescence and Scanning Electron Microscopy/Energy Dispersive Spectrometry.

EXPERIMENTAL:

Sediment samples collected at the quarry were analyzed by the following instrumentation: S-4 Pioneer Bruker X-Ray Fluorescence (XRF) Spectrometer Instrument, and Aspex/ RJ Lee Personal Scanning Electron Microscope/Energy Dispersive Spectrometer. All samples /rocks were broken down with a mortar and pestle into fine powder before placed into the XRF instrument.

RESULTS/DISCUSSION:

The STONE program has allowed the participating K-12 teachers to integrate novel technology and has focused attention on the high school teachers. These participating high school teachers have integrated the novel technology such as the XRF and the SEM/EDS to analyze rock samples and concrete samples. The industrial collaborator Bowser-Morner has been an excellent partner in this program STONE to encourage teachers and students to utilize the latest technology while developing skills needed for industry jobs in this setting. Figure 1 displays ancient rock sample that was analyzed for fluoride ions. The XRF allows the rock sample to interact with radiation. The rock material is excited with high energy and short wavelength radiation hits the rock sample and thus the material becomes ionized. When the energy of the radiation is sufficient to dislodge the tightly held inner-electron then the atom becomes unstable and the outer electron replaces the missing inner electron thus fluorescent radiation as shown in Figure 1.

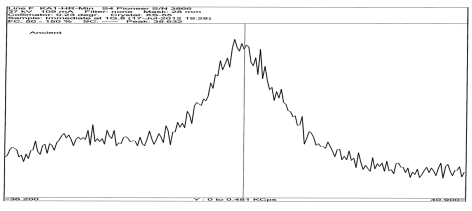


Figure 1. Ancient rock sample displayed Fluoride ions.

The STONE project was focused on the aggregate industry and how to produce concrete, which was a focus of the field trip at Bowser-Morner. The in-service teachers during the academic year require their own students to make stable concrete product and undergo testing to determine the optimized conditions to produce the overall best concrete material. Figure 2A and Figure 2B illustrates the use of an SEM instrument from Bowser-Morner to examine their concrete samples (before adding acid and after adding acid). One of the inquiry activities was to examine their concrete samples before acid rain and after acid rain (Does acid rain change the concrete material?). These concepts can be further examined using SEM/EDS to study the different elements present on the surface as well, which integrates the chemistry and geology concepts further as well.

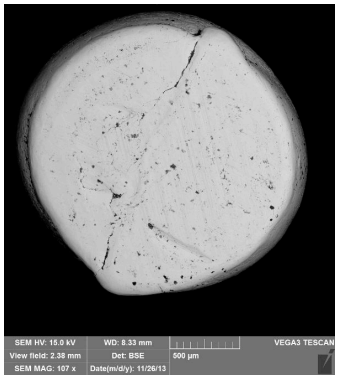


Figure 2A. SEM of Concrete sample with no acid rain.

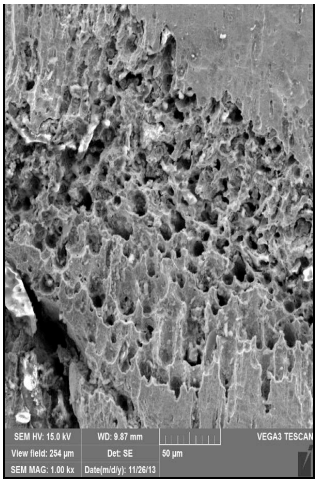


Figure 2B. SEM of Concrete sample with 0.1 M sulfuric acid rain.

CONCLUSION:

STONE has assisted the participating teachers to develop diversity in scientific thinking, The importance of personal experiences and connections with real scientist in industry, and communication of their findings while learning novel instrumentation and technology. Many students do not have the opportunity to transfer their learning knowledge into real-world applications. The content of looking at rock samples and examining for ions present focuses on the content area of geology and chemistry with real-world technology such as XRF instrumentation. This instrumentation was utilized to examine the non-metal anions such as F^- present. These field experiences have allowed our teaching participants to take a journey in the process of mine to mill

optimization thus drawing on the latest technology. Viewing mineral processing systems enable the participating teachers to learn about the concepts such as: grinding mills, crushers and screens, conveyors, separation equipment, slurry-handling equipment, pyro processing solutions, bulk materials handing equipment, wear products and mill linings. Pre- and Post-test surveys were performed of the participants and for their students as well to ensure a gain in content from these field experiences and hands-on labs with the aggregate industry. It was found that the participating teachers Normalized Gain was greater than 0.7, which typically are found for inquiry-based/hands on experiences in science classes [2]. These hands-on experiences and field trips have engaged students to learn and be excited about new technology in the aggregate industry [3-6].

The Pre- and Post-test exam questions engaged students into the following questions such as: What is the aggregate industry?, What is limestone?, What is an XRF?, What is an SEM?, What is concrete and what is cement?, Are concrete and cement the same or different and explain?, What is specific gravity and is in an important concept for industrial purposes in the aggregate industry?, What is OAIMA? These were the typical pre- and post-test questions that were part of the STONE program to ensure content knowledge was gained for the participating teachers and their own students as well. The participating teachers have continued field trips to industry such as Bowser-Morner, and Columbus Limestone Quarry, with their own students engaged in the real-world industrial experiences.

Project STONE participants in-service teachers have made such comments, as "they never understood what was an aggregate and what was the industrial process. It was intriguing to learn about the importance of the aggregate industry and how it is essential part in the state of Ohio." The Ohio Board of Regents funded this program and it has assisted the in-service teachers and their own students to excel in real-world science experiences that require their students to problem-solve and relate to future careers in the aggregate industry with technology [5-6].

ACKNOWLEDGEMENT: OAIMA and Patrick Jacomet, Executive director of the OAIMA for all their financial support and assistance setting up these field experiences. The OBR -Ohio Board of Regents for funding the STONE program as well.

REFERENCES:

1. G.M. Bodner , W.J.F. Hunter, R.S. Lamba, *The Chemical Educator*, **3**, 1-21 (1998).
2. R.R. Hake, *Am. J. Phys*., **66** (1) 64-74 (1998).
3. American Association for the Advancement of Science. *Benchmark for Science Literacy*; Oxford University Press: New York, 1994.
4. National Research Council. *Inquiry and the National Science Education Standards, A Guide for Teaching and Learning*; National Academy Press: Washington, D.C., 2000.
5. C. Chin & D.E. Brown *International Journal of Science Education*, **24**(5), 521–549 (2002).
6. M. Cole, *Computers & Education*, **52** (1), 141–146 (2009).

SCIENTIFIC AND TECHNOLOGICAL INNOVATION OF ANGOLA – The Case of the National Institute of Public Health Research of Angola

Eurico Ngunga
Fac. Ciências Sociais, Universidade Agostinho Neto
Luanda, Angola

Eduardo Mortimer
Fac. Educação, Universidade Federal de Minas Gerais
Belo Horizonte, Brasil

Abstract

Based on the concepts of innovation and National Systems of Innovation (NSI), this study sought to develop a research at the National Institute of Public Health of Angola (INSP-*in portuguese*) to understand the scientific and technological state development. In this sense, we rely on neoschumpeterians analysts who reinforce the importance of the National System of Innovation based on the co-evolution between what countries do and what people and institutions know how to do well.

Keywords: National Systems of innovation, Public Health, economic development.

1-Introduction

This work aims to present an approach overview of the scientific and technological innovation level in Angola, based on a survey conducted at the National Institute of Public Health of Angola. In regards to the new social and political scenario and economic development aspirations of Angola in the period after the civil war that lasted 27 years, we pose the following question: What is the current Angolan scientific and innovational level?

We rely on the concept of innovation and its systematic bias with technological development, because we believe that these elements are crucial and essential to the development of institutions and modern societies.

2-Concepts of Innovation

Several authors have discussed technological innovation, making distinctions between product and process innovation. Santelices (2010), states :

> "In general , we consider that innovation is the first application of science and technology in a new way with commercial success . Technological innovation includes new products and processes , as well as the important technological changes in products and processes . There is talk of innovation production when marketing a product has a technological change whereby the design features of a new product is improved. There is talk of process innovation when it introduces an important modification to the technology of production of an article . You can deal with a new team of new methods of management or organization or both types of exchanges associated" (SANTELICES , 2010, p.34).

In regards to this issues, people have been forced to seek strategies to improve their level of relationships among their neighbors, knowing that this is the crucial way for social, economic and mental success.

To succed, companies in general, are also driven to seek strategies to fit and stay in the market, studying and planning their actions around their ideal businesses. They are impelled to necessarily develop their skills and establish innovative strategies for strengthening between institutions to realize the opportunities to innovate their products and processes and thus be competitive in the market.

Joseph Schumpeter (1985) has brought a description of innovation as the introduction of a new product with, of course, differentiated quality. Also described innovation as the introduction

of new sort production methods and the establishment of new forms of economic organization , new ways of working relationship.

In this case, the author brings five different dimensions in which innovation is involved such as: 1) Introduction of a new well – i.e., a good that consumers are not yet familiar with- or of a new quality of good; 2) Introduction of a new production method , i.e., a method that has not yet been tested by experience in the manufacturing industry itself, which somehow needs to be based on a new scientific discovery; 3) Opening of a new market, or a market in which the particular branch of manufacturing industry in the country in question has not previously entered, whether this market has existed before or not. 4) conquest of a new source of supply of raw materials or semi-manufactured goods, again irrespective of whether this source already existed or had to be created. 5) Establishment of a new organization of any industry, like the creation of a monopoly position (e.g., by trustification) or fragmentation of a monopoly position (Schumpeter, 1985, p.76).

Other authors, have developed their approaches by applying them in different spheres, not only in the field of economic competence but also in the development of science and technology. For Nelson and Winter (2005, p.197), "this expression gives a useful emphasis to the fact that innovation in the economic system – and indeed the creation of any kind of novelty in the arts, sciences, or in practical life consist largely, recombinant materials and physical conceptual previously existed".

3-National System of Innovation(NSI)

There was a previously innovation understanding approach and its role in the economic development of societies. And for the realization of this innovation, be products or processes, there are many skills that must be taken into account, for instance, able to relate knowledge of scientific, technical and empirical and stay tuned to demands and opportunities of market. These skills, in the midst ideal for development, will lead necessarily to an effective systematization of actions surrounding their productions and innovations that may be necessary.

Within a general perspective, Pavitt (1984) provides a definition about the national innovation system as a set of institutions involved in the generation , commercialization and diffusion of new products, processes and services, as well as in terms of incentive structure and powers of these institutions exert an influence on the rate and direction of change that will derive from the changes in technology. Besides the prospect of Pavitt, to a greater understanding of the national system of innovation, as well other neoschumpeterianos authors as Freeman (2004), Dosi (1997) and Lundval (2003), defined several approaches to bring more contextual perspectives. In case Lundval (2003), for instance, there is concern in discussing effectively systematization of innovation, considering the national and local peculiarities.

In these approaches, there is an effort to broaden the understanding of NSI. On the other hand, for Johnson and Lundvall (2003, p.15), innovation is seen as a continuous cumulative process, involving not only radical and incremental innovation, but also the diffusion, absorption and use of innovation. Second, a broader set of sources of innovation should be taken into account.

It is noteworthy that, despite the different approaches regarding the national innovation system, as recalled above, there is a convergence (JOHNSON & LUNDVALL, 2003) in understanding. The first common

feature is the assumption that national systems differ in terms of specialization in production, trade and knowledge. In point of view of Lundvall and Johnson (2003), this is not a contradiction - for instance, the neoclassical trade theory could lead to a similar assumption. An important difference from the neoclassical theory, however, is that among the NSI analysts, the focus is on the co-evolution between what countries do and what people and businesses know how to do well. The structure of production and knowledge will change slowly and it change involves learning and structural change (JOHNSON & LUNDVALL, 2003, p.15).

The second common assumption behind the different approaches of national systems of innovation is that important elements of knowledge to economic activity are located and are not easily movable from one place to another. In this perspective, the common assumption is something more than information and that includes tacit elements (JONHSON & LUNDVALL 2003).

The third assumption, which becomes more noticeable in reference to knowledge, states that important elements of knowledge are embedded in the minds and bodies of the agents, a business routine, not least in the relations between people and organizations.

The fourth central assumptions to the idea of systems of innovation is focused on the interaction and relationships. It means that neither companies and knowledge institutions nor people innovate alone. This is, perhaps, the most basic feature approach of the system of innovation whose bulge is crucial "interactionist" (JONHSON & LUNDVALL, 2003, p.16).

4-National System of Innovation development challenges in Africa.

The medieval stories and contemporary paintings are illustrative of the actions perpetrated by the various companies in search of better living conditions. To this goal, these companies saw themselves forced to invade, plunder, enslave and even decimate entire populations to raise their survival skills. In this scenario, the strongest overlapping ended their practices "civilizing" at the expense of weaker or vanquished, forcing them to follow and adapting the norms and requirements. For Marx (2013, p.786), the true story, the main role is played by conquest, subjugation, and murder to steal, in short, by violence.

But history has also shown that the weak and/or losers, even in their meager forces, seek always to create outputs and subterfuge to escape such impositions. In the past thirty years (JAMISON, 2003, p.63), a conceptual approach has developed, regarding systemization of science, technology and innovation. The crucial question is in two unique biases that has been given to its implementation, especially by most national governments and supranational organizations such as the European Union, the United Nations, the African Union and SADEC (Community Development of Southern Africa). These biases are on one hand, "what to do with economic growth" one the other hand, "what to do with the 'social and environmental well-being'".

We noted above that Africa, before the colonial era, has availed himself of a local organization of nation states.

As a result of the Industrial Revolution, the introduction of the machine, however, allowed not only to carry out the work in much larger scale and speed, as the replacement of man in its direct physical work. The machine has become the central element of the technical production process. The shift from manufacturing to craft the factory resulted in profound changes, especially with the devaluation of the manual skill of the artisan, the destruction of social

relations of production to then current and breaking with tradition (LONGO, 2004, p.5).

In our point of view, it does not mean that the technological changes of several kinds should not happen. The truth is that there must be a systematic and pragmatic language that you understand the several nuances that make societies, lest they run the risk of deploying systems innovation as global; and imposing the risk of being little or nothing -productive and result in major setbacks for the development of these societies. What you have to do is strive for creation (a bias interactionist) of conditions for access to adequate technical knowledge. Within a view of Lea Velho (2011), several countries have different views on how to develop a society based on knowledge due, in part, to the stories, traditions, institutional structures, cultural values and styles of government of each.

5-General Situation of Angola and the National Institute of Public Health

Angola is situated in the southwest of the continent, on the western coast, in the southern region, between latitudes 4° 22' and 24° 05'. Composed by 18 provinces, 163 municipalities and 547 communes and 1,271 villages. It is bordered to the north by the Republic of Congo and the Democratic Republic of Congo, the east with the Republics of Congo and Zambia, to the south by the Republic of Namibia and west by the Atlantic Ocean to the extent of 1650 km (OLIVEIRA, 2010).

The years that followed the proclamation of independence in 1975 were of defense and territorial integrity where the country experienced a civil war that lasted 27 years and, as such, not only destroyed much of the industrial fabric and support but also lost a precious period for socio-economic development of the country. In the period that followed the realization of the peace process in 2002, Angola reportedly, sustained itself mainly by exports of oil and minerals (diamonds), macro-economic performance very dynamic and above the regional average and world, having been one of the countries most grown in these 11 years. Despite efforts by various governments, Africa remains the continent that has the lowest rates in terms of scientific and technological performance. This helps us to characterize the development of Higher Education in Africa in three main stages: The Colonial Higher Education, Higher Education After independence and the Current System of Higher Education.

Thus, the system of Higher Education in Angola, as in other African territories, was based specifically on the scholastic model, in which scientific research was insignificant. However, a universal experience proves that the University and the institutions that excel in research are the center of creation, innovation, dissemination and catalyzing the process of socio-economic development of a society.

After independence, this African country was not able to consolidate and develop the Universities and Scientific Research inherent to them for several reasons, such as: lack of experience in governance; lack of staff well prepared; brain drain; lack of investment.

All this is associated to the outbreak of civil war throughout Country. One of the greatest problems that most African countries face currently in order to the recovery and improvement R&D institutions and Higher Education. Africa, in general, is far from the level of innovation of the OECD (Organization for Economic Cooperation and Development).

The National Institute of Public Health (INSP) is one of the agencies attached to the Ministry of Health of Angola and is (in its chart) devoted to research in

the field of health. This institution, up until the time of this survey, has been called to resolve most situations of public health of the country, directing their actions in the fight against HIV and endemic diseases that plague the country. It's also dedicated to the analysis of water quality.

The INSP face the difficulties of other R&D institutions in Angola, due to the difficult environment of the national innovation system. Has been approved recently by the Angolan government, the National Policy on Science, Technology and Innovation in order to promote scientific research and technological innovation. However, actions for systematization of innovation are at a very early stage, for the very incipient scientific reality. During the 27 years of war, Angola had only one university, directing its activities exclusively in the areas of education and literacy. Consequently, several Angolan R&D institutions has worked in isolation.

6-Analysis Results

Methodologically, we accomplished a research in INSP (*in situ*) by talking to management and other technicians. Correspondingly, we performed an analysis of the chart to see the layout and its organizational planning in regards to the research. In order to obtain the results, the following items that enabled collection of the required information for the study was taken into account: 1. Type of Institution 2. Services; 3. Human resources;
4.Research carrier; 5. Infrastructure; 6.Technology; 7.Technology and equipment maintenance; 8. development of research and technological lines.

Table: Characteristics of the National Institute of Public Health (INSP)

Description:

#	Item	Constatação
1	Type of Institution	• Providing services in public health , and • Scientific research
2	Services Rendered	• Tropical deseases research • As endemic deseases • Water Quality
3	Human Resources	• Personnel Technician Specialty: -1 Doctor; - 6 Masters ; - 2 Postgraduates ; - 16 graduates ; - Bachelors 2 : - 32 Basic Technical / Medium (support Research • Administrative Staff : - 23 Administrative workers
4	Scientific Research Career	• It is difficult in the promotion of research; • Need for approval of technical career to support research in the following categories: - Researchers coordinators; - Principal investigators; - Researchers Auxiliary; - Research Assistants; - Research Interns.
5	Infrastructures	• Good facilities for the type of activity; • Insufficient for the quantity and diversity of work;
6	Technology	• In renovation (acquisition of new technology); • In process of certification of some technology
7	Maintenance of technology and equipment	• Difficulty in maintaining and restocking
8	Lines research and technological development	• Attempts to develop nuclear markers anti-malarials and HIV/AIDS

7-Discussion

In general, the institution has been technologically well equipped. This is a feature of most peripheral countries because local policies facilitate the import of technologies. According to the chart, the INSP are written by the national health system of the Ministry of Health, with the objective of investigating and creating mechanisms for preventing diseases and endemic diseases. But there are gaps in the full operation of the system, given the various problems listed below:1) High demand in root cause analysis and troubleshooting of the country endemic health. We conclude that the INSP is connected to the national health system of the Ministry of Health, with the

objective of investigating and creating mechanisms for preventing diseases and endemic diseases . But there are gaps in the full operation of the system, given the various specific difficulties in great demand in analyzing the causes and solving the country's endemic health problems. The Institute has been asked to identify the causes and solutions to the outbreaks of cholera, malaria, HIV/AIDS and other endemic diseases that occur throughout the country. Angola has made up of 17 provinces with institutions that are working in the same objective that unfortunately they aren't fully capable of succeeding due to lack of well prepared of technicians and researchers.In the point of view of Velho (2011), there is a great need to understand and analyze the different ways, social, cultural, historical and political as they are constituted various societies, the various levels of development where they are and their capabilities to produce and use knowledge for their own progress. The reality of Angola does not escape this thought, for analyzing the Angolan reality, the other provinces are far below the level of social and economic development in relation to Luanda.

8- Recommendations

In general, there is a need for a technical training plan in the short, medium and long-term, as part of an Institutional Development Project and define the research lines and their respective projects, associated with better partnerships with national and international universities. Likewise, various other actors are required in order to contemplate a broader level, to innovate work processes and research for the effective eradication of tropical diseases plaguing Angola.

In sum, it may be said, without investment in human resources, it is impossible to promote scientific research and innovations in the field of public health in Angola. Taking into account the recommendations of Oslo Manual, promoting training opportunities, will be possible to get innovations capabilities in the use of technology, with due responsibility and critical sense. Also they will have innovation capacity in the private sector and public health, developing resources to enhance well fare throughout the country.

9-References

LONGO, Waldimir Pirró e Longo. **Ciência e Tecnologia**: Evolução e inter-relação e perspectivas. Artigo Publicado na "A DEFESA NACIONAL".jul. de 2004.

LUNDVALL, B.-A. Putting África First: **The making of African Innovations Systems**. Aalborg University Press. 2003.

MARX, Karl. **O capital: crítica da economia política**: livro 1º: O processo de produção do capital/Karl Marx; São Paulo: Boitempo, 2013.

MINISTÉRIO DA SAÚDE. Estatuto Orgânico. www.minsa.gov.ao. Acessed in 11/10/2013.

NELSON, Richard R.,1930 – **Uma teoria evolucionária da mudança econômica**/Richard R. Nelson e Sidney G. Winter; tradutor: Cláudio Heller. – Campinas, SP: Editora da UNICAMP, 2005.

OLIVEIRA, M.S. **Processo de Descentralização do Serviço Nacional de Saúde de Angola**. RJ. FIOCRUZ. 2010.http://bvssp.icict.fiocruz.br/pdf/25868_oliveiramsd.pdf. Acessed on 09/10/2013.

NELSON, R. **As fontes do crescimento econômico. (**Clássicos da Inovação) – Campinas, SP: Editora da UNICAMP, 2006.

SCHUMPETER, J. A. **Capitalismo, socialismo e democracia**. São Paulo: Abril, 1985.

VELHO, Lea. **Conceitos de Ciência e a Política Científica, Tecnológica e de Inovação**. Sociologias, Porto Alegre, ano 13,nº26, jan/abr. 2011, p.128-153.

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