

# The 14<sup>th</sup> World Multi-Conference on Systemics, Cybernetics and Informatics

June 29th - July 2nd, 2010 - Orlando, Florida, USA

# PROCEEDINGS Volume IV

(Post-Conference Edition)

Edited by:

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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-13: 978-1-934272-97-8 (Collection) ISBN-13: 978-1-936338-10-8 (Volume IV)



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| Kerooyan, KnamkRussian-Armenian (Slavonic) UniversityUSAKeyhanipour, Amir H.University of TehranIranKhalifa, Abdul JabbarNahrain UniversityIraqKhudayarov, BakhtiyarTashkent Institute of Irrigation and MeliorationUzbekistanKibarer, GunayHacettepe UniversityTurkeyKilic, YavuzAllegro MicroSystems Europe Ltd.UKKim, DohoonKyung Hee UniversitySouth KoreaKim, E-JaeLG Electronics Institute of TechnologySouth KoreaKim, HakyongLG TelecomSouth KoreaKim, Hyung NamVirginia TechUSAKim, Tae YongChung-Ang UniversitySouth KoreaKing, RogerUniversity of ColoradoUSAKinser, JasonGeorge Mason UniversityUSAKoenderink, Jan J.University of SheffieldUKKonno, AtsushiTohoku UniversityJapanKopeika, NatanBen-Gurion UniversitySwedenKopika, NatanBen-Gurion UniversitySwedenKopika, NatanLeeds Metropolitan UniversitySwedenKor, Ah-LianLeeds Metropolitan UniversityWKKrabina, BernhardKDZAustriaKoumov, ValeriOkayama University of ScienceJapanKsenofontov, AlexandreMoscow Engineering Physics InstituteRussian FederationKung, Hsiang-JuiGeorgia Southern UniversityUKKranno, AtsushiTohoku University of ScienceJapanKopeika, NatanGeorgia Southern UniversitySweden<  | Kazi, Halleeuullali                    | Bussien American (Slavania) University                       | Pakistan              |
| Keynanipour, Amir H.University of TehranIranKhalifa, Abdul JabbarNahrain UniversityIraqKhudayarov, BakhtiyarTashkent Institute of Irrigation and MeliorationUzbekistanKibarer, GunayHacettepe UniversityTurkeyKilic, YavuzAllegro MicroSystems Europe Ltd.UKKim, DohoonKyung Hee UniversitySouth KoreaKim, E-JaeLG Electronics Institute of TechnologySouth KoreaKim, HakyongLG TelecomSouth KoreaKim, HyunjuJackson State UniversityUSAKim, Yong K.Wonkwang UniversitySouth KoreaKinser, JasonGeorge Mason UniversityUSAKinser, JasonGeorge Mason UniversityUSAKoene, AnsgarUniversity of TokushimaJapanKoene, AnsgarUniversity of SheffieldUKKonou, AltsushiTohoku UniversitySwedenKopeika, NatanBen-Gurion UniversitySwedenKor, Ah-LianLeeds Metropolitan UniversitySwedenKor, Ah-LianKDZAustriaKrabina, BernhardKDZAustriaKoumov, ValeriOkayama University of ScienceJapanKsenofontov, AlexandreMoscow Engineering Physics InstituteRussian FederationKugung, Hsiang-JuiGeorgia Southern UniversityUKKrabina, BernhardKDZAustriaKoumov, ValeriOkayama University of ScienceJapanKsenofontov, AlexandreMoscow Engineering Physics InstituteRussian FederationKung, Hsu-  | Kerobyan, Knanik                       | Russian-Armenian (Slavonic) University                       | USA                   |
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| Kopeika, NatanBen-Gurion UniversityIsraelKoptyug, AndreyMid Sweden UniversitySwedenKor, Ah-LianLeeds Metropolitan UniversityUKKrabina, BernhardKDZAustriaKroumov, ValeriOkayama University of ScienceJapanKsenofontov, AlexandreMoscow Engineering Physics InstituteRussian FederationKung, Hsiang-JuiGeorgia Southern UniversityUSAKung, Hsu-YangNPUSTTaiwan   | Konno, Atsushi                         | Tohoku University  | Japan                 |
| Koptyug, AndreyMid Sweden UniversitySwedenKor, Ah-LianLeeds Metropolitan UniversityUKKrabina, BernhardKDZAustriaKroumov, ValeriOkayama University of ScienceJapanKsenofontov, AlexandreMoscow Engineering Physics InstituteRussian FederationKung, Hsiang-JuiGeorgia Southern UniversityUSAKung, Hsu-YangNPUSTTaiwan  | Kopeika, Natan                         | Ben-Gurion University  | Israel                |
| Kor, Ah-LianLeeds Metropolitan UniversityUKKrabina, BernhardKDZAustriaKroumov, ValeriOkayama University of ScienceJapanKsenofontov, AlexandreMoscow Engineering Physics InstituteRussian FederationKung, Hsiang-JuiGeorgia Southern UniversityUSAKung, Hsu-YangNPUSTTaiwan  | Koptyug, Andrey                        | Mid Sweden University  | Sweden                |
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| Masum Salahuddin          | CSE  | Bangladesh     |
| Mathkour Hassan           | King Saud University                                 | Saudi Arabia   |
| Matsuda Michiko           | Kanagawa Institute of Technology                     | Janan          |
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| mention, man              |  |                |

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| Minin, Alexey                | Saint-Petersburg State University                       | Russian Federation |
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| Morshed Ahmed                | Ain Shame University                                    | Favot              |
| Mozar Stefan                 | CCM Consulting  | Australia          |
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| Nour Eddine, Alaa            | Cadi Ayyad University                                   | Morocco            |
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| Onwubiko, Cyril                       | Kingston University                                 | UK                        |
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| Larab, Ali                | ISIS   | France    |
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| Pécatte, Jean-Marie       | ISIS   | France    |
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| Sahara, Tomohiro          | Osaka Institute of Technology                | Japan     |
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| Vonck, Kristl             | Ghent University Hospital                    | Belgium   |
| Vu, Khuong                | Texas Tech University                        | USA       |
| Wang, Yu                  | Marquette University                         | USA       |
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| Shin, Jungpil           | University of Aizu                                     | Japan                     |
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The 6th International Symposium on Management, Engineering and Informatics: MEI 2010 in the context of The 14th Multi-conference on Systemics, Cybernetics and Informatics: WMSCI 2010



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# **Number of Papers Included in these Proceedings per Country** (The country of the first author was the one taken into account for these statistics)

| Country              | # Papers | %      |
|----------------------|----------|--------|
| TOTAL                | 242      | 100.00 |
| United States        | 56       | 23.14  |
| Japan                | 22       | 9.09   |
| South Korea          | 12       | 4.96   |
| Germany              | 11       | 4.55   |
| China                | 10       | 4.13   |
| France               | 9        | 3.72   |
| Czech Republic       | 7        | 2.89   |
| Slovakia             | 7        | 2.89   |
| Australia            | 6        | 2.48   |
| Israel               | 6        | 2.48   |
| India                | 5        | 2.07   |
| Taiwan               | 5        | 2.07   |
| Thailand             | 5        | 2.07   |
| Brazil               | 4        | 1.65   |
| Canada               | 4        | 1.65   |
| Mexico               | 4        | 1.65   |
| Russian Federation   | 4        | 1.65   |
| Spain                | 4        | 1.65   |
| United Kingdom       | 4        | 1.65   |
| Hong Kong            | 3        | 1.24   |
| New Zealand          | 3        | 1.24   |
| Poland               | 3        | 1.24   |
| Portugal             | 3        | 1.24   |
| Argentina            | 2        | 0.83   |
| Austria              | 2        | 0.83   |
| Chile                | 2        | 0.83   |
| Denmark              | 2        | 0.83   |
| Italy                | 2        | 0.83   |
| Kenya                | 2        | 0.83   |
| Malaysia             | 2        | 0.83   |
| Netherlands          | 2        | 0.83   |
| Romania              | 2        | 0.83   |
| South Africa         | 2        | 0.83   |
| Sweden               | 2        | 0.83   |
| Turkey               | 2        | 0.83   |
| United Arab Emirates | 2        | 0.83   |
| Algeria              | 1        | 0.03   |
| Belgium              | 1        | 0.41   |
| Colombia             | 1        | 0.41   |
| Croatia              | 1        | 0.41   |
| Finland              | 1        | 0.41   |
| Greece               | 1        | 0.41   |
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## Foreword

Our purpose in the 14<sup>th</sup> World Multi-Conference on Systemics, Cybernetics and Informatics (WMSCI 2010) 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.

Systemics, Cybernetics and Informatics (SCI) are being increasingly related to each other in almost every scientific discipline 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 WMSCI 2010 as a multi-conference where participants may focus on one area, or on one discipline, while allowing them the possibility of attending conferences 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.

WMSCI 2010 was organized and sponsored by the International Institute of Informatics and Systemics (IIIS), member of the International Federation of Systems Research (IFSR). 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.

These IIIS objectives have directed the organizational efforts of yearly WMSCI/ISAS conferences since 1995.

On behalf of the Organizing Committee, I extend our heartfelt thanks to:

- 1. the 1759 members of the Program Committee from 67 countries;
- 2. the 1127 additional reviewers, from 82 countries, for their **double-blind peer** reviews;
- 3. the 714 reviewers, from 79 countries, for their efforts in making the **non-blind peer reviews**. (Some reviewers supported both: non-blind and double-blind reviewing for different submissions).

A total of 3586 reviews made by 1841 reviewers (who made at least one review) contributed to the quality achieved in WMSCI 2010. This means an average of 5.04 reviews per submission (711 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 WMSCI 2010, about 711 papers/abstracts were submitted. These pre-conference proceedings include about 242 papers that were accepted for presentation from 55 countries. I extend our thanks to the invited sessions' organizers for collecting, reviewing, and selecting the papers that will be presented in their respective sessions. 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 about WMSCI 2010 is summarized in the following table, along with the other collocated conferences:

| Conference | # of<br>submissions<br>received | # of reviewers<br>that made at<br>least one<br>review | # of reviews<br>made | Average of<br>reviews per<br>reviewer | Average of<br>reviews per<br>submission | # of papers<br>included in the<br>proceedings | % of<br>submissions<br>included in the<br>proceedings |
|------------|---------------------------------|---|----------------------|---------------------------------------|---|---|---|
| WMSCI 2010 | 711                             | 1841  | 3586                 | 1.95                                  | 5.04                                    | 242   | 34.04%  |
| IMETI 2010 | 425                             | 1124  | 2480                 | 2.21                                  | 5.84                                    | 134   | 31.53%  |
| IMSCI 2010 | 321                             | 720   | 1751                 | 2.43                                  | 5.45                                    | 131   | 40.81%  |
| CISCI 2010 | 622                             | 1174  | 3321                 | 2.83                                  | 5.34                                    | 224   | 36.01%  |
| TOTAL      | 2079                            | 4859  | 11138                | 2.29                                  | 5.36                                    | 731   | 35.16%  |

We also extend our gratitude to the focus symposia organizers, as well as to the co-editors of these proceedings, for the hard work, energy and eagerness they displayed preparing their respective sessions. 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, and as Honorary President of WMSCI 2010, 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 Sanchez, who brilliantly managed the organizing process.

Our gratitude to Professors Bela H. Banathy, Stafford Beer, George Klir, Karl Pribram, Paul A. Jensen, and Gheorghe Benga who dignified our past WMSCI conferences by being their Honorary Presidents. Special thanks to Dr. C. Dale Zinn and Professor Jorge Baralt for co-chairing WMSCI 2010 Program Committee and to professors Andrés Tremante and Belkis Sánchez for co-chairing the Organizing Committee. We also extend our gratitude to Drs. W. Curtiss Priest, Louis H. Kauffman, Leonid Perlovsky, Stuart A. Umpleby, Eric Dent, Thomas Marlowe, Ranulph Glanville, Karl H. Müller, and Shigehiro Hashimoto, for accepting to address the audience of the General Joint Plenary Sessions with keynote conferences, as well as to Dipl.-Math Norbert Jastroch, Professor Dieter Fensel, and Dr. Peter A. Curreri for accepting our invitation as Keynote Speakers at the Plenary Session of WMSCI 2010.

Many thanks to Drs. Dale Zinn, Jorge Baralt, Hsing-Wei Chu, Andrés Tremante, Friedrich Welsch, Thierry Lefevre, José Vicente Carrasquero, Angel Oropeza, and Freddy Malpica for chairing and supporting the organization of the focus symposia and conferences in the context of, or collocated with, WMSCI 2010. We also wish to thank all the authors for the quality of their papers.

We extend our gratitude as well to Maria Sanchez, Juan Manuel Pineda, Leonisol Callaos, Dalia Sánchez, Keyla Guedez, Nidimar Díaz, Yosmelin Márquez, Riad Callaos, Marcela Briceño, Pedro Martínez, Louis Barnes, and Katerim Cardona for their knowledgeable effort in supporting the organizational process and for producing the hard copy and CD versions of the proceedings.

Professor Nagib C. Callaos WMSCI 2010 General Chair

#### WMSCI 2010 The 14th World Multi-Conference on Systemics, Cybernetics and Informatics The 2nd International Symposium on Peer Reviewing: ISPR 2010 International Symposium on Science 2 and Expansion of Science: S2ES 2010 International Symposium on Design and Research in Artificial and Natural Sciences: DRANS 2010 The 4th International Symposium on Bio- and Medical Informatics and Cybernetics: BMIC 2010 The SUMMER 4th International Conference on Knowledge Generation, Communication and Management: KGCM 2010 The 7th International Symposium on Risk Management and Cyber-Informatics: RMCI 2010

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#### **Epistemic Conservatism in Peer Review: A Burkean Defense**

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#### Abstract

Epistemic conservatism (EC) is common in peer review and at the same time seems antithetical to the innovation ideas and knowledge that peer reviewed articles, conference proposals, and grant proposals are supposed to provide. David Shatz recommends "two strategies for removing [EC's] obstacle to innovation": attack the use of EC or "identify goals of publication other than avoidance of error or the delivery of the truth." But there is a third possibility which, if reasonable, will make room for both EC and innovations. We might offer a specific, albeit stipulative definition of "conservative" that has historical and conceptual support and that, if applied, makes room for innovation while preserving much of what EC has to recommend it. This strategy will rely on Edmund Burke's introduction of "conservative" into the academic and political lexicon and compare it with three other definitions of conservative. This essay argues that critics of EC in peer review of scientific and engineering scholarship should consider four meanings of "conservative." In so doing they may find EC and innovation potentially compatible rather than antithetical, thus settling one common objection to peer review.

**Keywords**: Peer Review, Epistemic Conservatism, Innovative Ideas, Burkean Conservatism

Writing about the recent discovery of default activity in the brain, *Newsweek*'s Sharon Begley[1] notes that its very idea "was so contrary to the herd wisdom that when [neurologist] Marcus Raichle [2], one of its discoverers, submitted a paper about it, a journal rejected it." *In Peer Review: A Critical Inquiry*, David Shatz [3] devotes a chapter to "epistemic conservatism" while asking the questions "Is Peer Review Inherently Conservative? Should It Be?"

Let us accept the similarity of meaning between Begley's "herd wisdom" and Shatz's "epistemic conservatism" (EC), and agree to use the latter in this essay. Then we can agree that both popular media and academic scholarship posit the common and potentially troubling occurrence of EC in scholarly peer review.

According to Psychology Professor Liora Schmelkin [4] EC is one of several alleged problems with peer review, and may reflect or contribute to many of these others issues. Among the issues it may reflect are biased reviewers; subjective reviewers; incompetent reviewers, who are unable to detect fraud, illogic, or bad methodology; self-serving reviewers; uncivil reviewers; reviewers unable to handle dissent or controversy; the secretiveness of the review process; the "incestuousness" of the peer review process, "especially in small, narrowly defined specialty areas; and the susceptibility of the peer review process to "various forms of political pressure." Concerns to which EC may contribute include publication of papers that are unscientific or "grossly flawed"; a stifling of scientific communication and hence a slowing of the advancement of knowledge; and "potential dishonesty among reviewers who sometimes steal ideas from the manuscripts they review." For these reasons some critics condemn peer review for being irrelevant, unnecessary, or harmful.

As Shatz [3] argues, despite the objections to EC, it is common in peer review and it appears to be at odds with innovation, which is a key goal of academic scholarship. In positing the ubiquity of EC and its challenges to innovation—and thus to one of the main purposes of journal and book publication, conference presentations, and grant requests—Shatz [3] recommends "two strategies for removing [EC's] obstacle to innovation": attack the use of EC or "identify goals of publication other than avoidance of error or the delivery of the truth" (p. 100)

But there is a third possibility which, if reasonable, will make room for both EC and innovations. We might offer a specific, albeit stipulative definition of "conservative" that has historical and conceptual support and that, if applied, makes room for innovation while preserving much of what EC has to recommend it. This strategy will rely on Edmund Burke's introduction of "conservative" into the academic and political lexicon and compare it with three other definitions of conservative. This essay argues that critics of EC in peer review of scientific and engineering scholarship should consider four meanings of "conservative." In so doing they may find EC and innovation potentially

- (i) Scholarship should add to the body of knowledge.
- (ii) Adding to the body of knowledge requires innovative ideas.
- (iii) Scholarly peer review should promote this innovation.
- (iv) EC stifles innovation.
- (v) Therefore, peer review should avoid EC.

Premise (i) is uncontroversial. Premise (iii) follows from (i) and (ii) Before considering (ii) and (iv) brief

comments on "innovation" and "peer review" are in order. That innovation is valuable, if not essential, to scholarship is obvious. What constitutes innovation is less clear. Here we may find useful the view of 17<sup>th</sup> Century Muslim scholar Shams al-Din al-Babili [5]: A new work must exclusively undertake one of seven matters: to create something unexpected; to complete something unfinished; to clarify something confused; to summarize something verbose; to put in order something disordered; to unify something fragmented; or to rectify something erroneous.

Spier [6] notes that any effort of the sorts al-Babili describes can be innovative in 3 ways: by taking small steps, by offering a scientifically substantiated new idea, or by challenging the accepted norms (pp.100-101). Since all of al-Babili's meanings are worthwhile, we need not select one meaning exclusively. But it will be useful to recognize Spier's third way as central to the apparent tension between EC and innovation.

To be sure unfettered innovation might lead to bad science, fraud, and the harm that can come from these. For example, an editorial in *Nature* [7] acknowledges and "strongly rejects" the charge that "in order to compete or publish exciting results, journals will cut corners in peer review, overrule hostile reviews, or select sympathetic ones." But this is not an indictment of innovation so much as a warning to proceed carefully in recommending publication or acceptance of an innovative conference paper or grant proposal. Andrei Alexandrou, et al. [8], for example, offer useful "suggestions for reviewing manuscripts," which if followed carefully will go a long way toward promoting innovation carefully (p. 244). These include attention to

- Methodological Validity
- Originality
- Significance of findings
- Style and clarity of presentation

compatible rather than antithetical, thus settling one common objection to peer review.

We may begin with the following argument as a general summary of criticisms of EC:

- Interest to readership
  - Whether results support claims or conclusions
- Whether the abstract correctly reflects the full context of the manuscript

We are also assuming the valuable role of peer review, Prof. Schmelkin's list of objections notwithstanding. Karen Stein [9] puts this well in her discussion of the Committee on Publication Ethics. As she notes, the journal publisher Elsevier acknowledges that "the publication of an article in a peer-reviewed journal is an essential building block in the development of a coherent and respected network of knowledge" (p. 794). A fairly recent editorial in *The Lancet* [10] declares that "Without peer review the whole edifice of scientific research and publication would have no foundation."

With this understanding about innovation and peer review let us take a closer look at premises (ii) and (iv). Premise (ii) is intuitively reasonable, but invites this question: to what extent should the proposal establish truth? Must the author offer sufficient evidence for the thesis, thus heeding W. K. Clifford's [11] claim that "it is wrong always, everywhere, and for anyone to believe anything upon sufficient evidence"? Or is it enough to propose a new hypothesis with sufficient support to deserve further consideration, thus affirming William James' [12] rejoinder to Clifford that "we have a right to believe at our own risk any hypothesis that is live enough to tempt our will"?

A good argument can be made for the latter. As Jennifer Couzin [13] notes, "Peer review doesn't necessarily say that the paper is right, it says that it's worth publishing" (p. 23). One might also entertain the possibility that, as Adam and Knight [14] put it, "the real peer review only starts when [the paper] is published" (p. 776). Further support comes from John Stuart Mill's [15] call for "freedom of opinion, and freedom of the expression of opinion, on four distinct grounds":

- The controversial thesis could be true;
- Even a flawed thesis may contain truth;
- Even if true, it needs to be "vigorously and earnestly contested" to keep it vibrant.
- Otherwise it may become dogma.

If James, Couzin, Adam & Knight, and Mill are correct, then EC on its face seems all the more

demonstrably antithetical to innovation. Thus premise (iv) appears to be true, especially if EC is dogmatic, a point Lindsay Waters [16] makes emphatically, claiming that "Contemporary society pays lip service to the innovator, but really loves the conformist" (p. 56). She posits this because "our willingness to make fools of ourselves is the first link in the chain that holds us in bondage" (p. 7). In this vein Spier [6] adds that historically, "papers which contained ideas that were contrary to the dominant paradigm tended to be rejected" (p. 101). Shatz [3, p. 90] includes several examples (See also Campanario [17]):

- Edward Jenner's 1796 paper on smallpox vaccination
- Hans Kreb's early work on citric acid cycles (c. 1937)
- Bruce Glick's early work on Blymphocytes (c. 1956)
- Murray Gell-Mann's early work on quarks (c. 1960)

Thus, the peer reviewer faces quite a challenge, since EC appears to be rampant both historically and at present. But a dogmatic notion of conservatism need not be the only one in peer review. In political discourse, the word "conservative" has four meanings (Michael Kinsley [18] has discussed all but the third):

- Resistant to change.
- Having a particular moral agenda, often in sympathy with conservative religious views, such as defense of "creationism" against evolution.
- Resistant to big government.
- Taking the lessons of history seriously in making important decisions.

The first sense is relevant to our discussion to the extent that it reflects the common criticism about EC.

The second sense would be relevant where, e.g., a "conservative" peer reviewer rejected an article simply for condemning intelligent design as bad science.

The third sense is not directly relevant, although one might adapt it, e.g., to a debate about the power peer reviewers have to affect careers.

The fourth and original sense is what concerns us most here. It comes from Edmund Burke (1729-1797) [19]. For Burke, a conservative takes the lessons of history seriously and will consult history whenever possible before making important decisions. A century later, Spanish-American Philosopher George Santayana [20] would echo this sentiment in his famous claim that "Those who cannot remember the past are condemned to repeat it."

When Marcus Raichle [21] first posited rich and organized activity in the brain during moments such as staring into space, being under anesthesia, or sleeping, this flew in the face of established neuroscience. So convinced were the experts that no such activity existed, that the primary technology for measuring brain activity-such as PET scans and MRIs-were not calibrated to account for it. Nor were peer reviewers for medical journals inclined to recommend publication of papers that argued for such activity. But with Raichle's discoveries, neuroscience faced, as Begley [1] puts it, "its dark energy moment." Just as contemporary cosmology has come to admit that most of what is "out there" may not yet have been accounted for, neuroscience is coming to admit the severe limits of its previous scope of investigation. Without the innovative thinking of Raichle and others of like mind, neuroscience might still be behind the times. Without an historical understanding of the problem, reviewers might not have progressed and a competent reviewer might have missed the constructively innovative value of Raichle's hypothesis.

In brief, Raichle [21] and colleagues determined that "a baseline or control state is fundamental to the understanding of most complex systems," including the brain. While conventional neuroscience presumed the activity of a "resting" brain would "vary unpredictably," Raichle found that a "ratio of oxygen used by the brain to oxygen delivered by flowing blood" showed a predictable fluctuation between oxygen delivered to the brain and the brain's oxygen consumption that permitted establishment of a baseline for brain activity which in turn permitted use of Pet scans and MRIs to show the existence of an active brain in default mode. For reasons beyond the scope of this discussion, neuroscientists believe that this discovery has significant implications for the study of disorders such as schizophrenia, autism, and Alzheimer's disease.

For our purposes what matters for the careful reviewer is (1) the researchers were well aware of the history of their field of study; (2) the untapped promises that this history suggested, especially regarding use of MRIs and PET scans, and the reviewer's duty to recognize these promises; and (3) the tenacity to pursue a line of inquiry that defied the neuroscientists norms of the day, which history itself shows to be necessary to move knowledge forward.

It is also worth noting that sufficient peer review support finally arose to give Raichle the

venue he needed to add his valuable work to the body of knowledge. How much this is due to direct defiance of EC by the reviewers and how much the reviewers were enlightened by a clear understanding of the history of neuroscience remains an open question.

At this point we may, with Shatz [3] propose "demarcate[ing] cases of ideological bias from cases of legitimate conservatism" (pp. 87-88). Legitimate conservatism requires reviewers to, in Spier's [6] words "root out those areas where there are benefits and discard the remainder [, which requires the reviewer to be] bold and temperate; courageous and pragmatic; adventurous and prudent...it takes a maverick to make the first moves to tame the untamable" (p. 106). In this light, the epistemically conservative reviewer may give added weight to the prevailing paradigm, but she will also recognize the value of being open to innovative adjustment of the paradigm, innovative ideas that nevertheless comport with the paradigm, or outright rejection of that paradigm-a recognition that comes with a broad historical understanding of paradigms and paradigm shifts, the negative lessons learned from stifling conservatism, and the positive lessons learned from making room for constructive innovation.

Note that in addition to encouraging "legitimate' or Burkean EC, we may argue that the scope and limits of EC are best understood historically, which can help the peer reviewer identify when to stand firm and when to encourage innovation. And per Couzin, Mill, and James, this history is clearly on the side of promoting innovation.

In short, EC may exist in the sense that common criticism implies, but it could also exist in the Burkean sense, which would permit those instances of EC to promote rather than stifle innovation.

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#### What Is the Value of Peer Review – Some Sociotechnical Considerations

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#### ABSTRACT

Scientific and technical knowledge of the world grows through individual processes of speculation, making and documenting knowledge claims, the social processes of circulating and testing them, and the cyclic iteration of these processes to incrementally build on what is already known. Formal publication of claims in journals has been critical to circulating and critiquing new knowledge claims.

Editorial peer review supposedly justifies the costs of the publishing activities surrounding it. Yet publishing costs, largely paid by libraries, have become unsustainable. Also, the costs discourage many from publishing and limit access of others to what is published.

Today's editorial peer review results from the exponential growth and specialization of the sciences in the second half of the 20<sup>th</sup> Century, but offers little genuine epistemic value. It may actually thwart the advancement of innovative and revolutionary research.

Following Popperian evolutionary epistemology, we consider the social and epistemological dynamics of editorial peer review. We also note that that the ever increasing sophistication of digital technologies extending our cognitive capacities provides a pathway to very substantially reduce the cost of publishing whilst at the same time increasing the transparency and value of genuine peer review.

**Keywords:** Organization Theory, Karl Popper, Evolutionary Epistemology, Internet Technology, Publishing

#### INTRODUCTION: WHAT FORMAL PUBLISHING IS SUPPOSED TO ACHIEVE

In the last two decades, as electronic formats and media have increasingly replaced paper, the processes for formalizing knowledge have been undergoing the greatest socio-technological revolution since the invention of the printing press and the scientific journal [14] [17] [33] [78] [12]. This revolution is fundamentally changing the publishing process itself in ways that we cannot yet foresee [11] [46]. We believe that these changes will especially impact editorial peer review.

The first formal scientific journals, the Journal des Sçavans and the Proceedings of the Royal Society (London) were established in 1665 [17]. According to Fjällbrant, publishing in such formal journals offered a number of advantages to authors and the scientific community:

- 1. information can be spread to a widely scattered group of readers;
- detailed information, such as descriptions of methods, tables, diagrams, results etc can easily be given;

- 3. printed documents contain information which can be critically examined and verified;
- 4. the documents can easily be referred to as and when required;
- published documents provide a means for establishing "priority" of academic work, and thereby contribute to establishing academic merit for the author(s) [17].

Many scientists recognize the need to have their work "evaluated and validated" by their peers before incorporating it into the body of scientific knowledge as a foundation for further knowledge building. Through most of the history of scientific publishing, such evaluation was primarily considered to be a post-publication process. Because until comparatively recently few journals preserved archives of their editorial processes, the historical development of the process is murky. Much of what is known of the history was surveyed in the First International Congress on Editorial Peer Review in Biomedical Publication held in 1989 [65]. Most of what we have to say here about present processes was already apparent from that conference.

Peer review was first implemented in 1752 by the Royal Society of Edinburgh [51] [66] who used a select group of members to make recommendations to the editor about the quality of submitted articles. However, peer review remained sporadic through the mid 20<sup>th</sup> Century [6] [66] [7]. Most editors knew their fields, and had to work hard to find enough even barely publishable papers to fill their journals [6]. What editorial support was provided to authors via editorial boards or peers apparently was focused on finding articles and improving the quality of expression and presentation. At least through the Second World War, if a scientist had a story to tell it was comparatively easy to find a publisher who would help present the manuscript. According to the editors and publishers of early journals [51] [6] [66], the act of publishing did not imply that the claims to knowledge as published carried any stamp of approval that they were certified "safe to use" for application or for building further knowledge.

After the War, the number of increasingly narrowly specialized scientists began to grow exponentially; while the number of research journals numbers grew more slowly than the numbers papers submitted and scientists writing them. Editors also became more specialized, and les able to cover all disciplines their journals covered. Peer review was increasingly used by editors to help choose the "best" papers and reject the worst, and thus improve the quality of the product in an increasingly competitive publishing environment. Competition by journals for best papers provided readers with a way to prioritize their reading to the "best" journals [7]. In turn, academic and research administrators considering scientists for promotion or grants, but who lacked qualifications to assess the authors' work directly, increasingly determined authors' "worthiness" by the number of papers published.

Consequently, rather than focusing primarily on research and originality, authors faced increasing pressure to maximize the number of papers published. As more people submitted ever more papers, rejection rates rose to where a popular journal might have to review 10 papers for every one accepted. The journal Science now rejects around 92% of original research papers submitted [71], and other top journals probably have similar rejection rates [54]. Besides contributing to the journals' publishing costs, the long cycle of write - submit - review reject/revise - resubmit... takes months or years between completing a paper and its appearance in the formal literature. Thus, many authors focus on writing short, "safe", and readily acceptable papers; and less on genuinely original research that crosses boundaries and establishes new paradigms [52] [53]. Most journals are narrowly specialized, as are most reviewers. This creates more difficulties for publishing genuinely innovative, cross disciplinary or paradigm shifting work.

In our own personal experiences with submissions, the dynamics of the existing review process makes it difficult to find acceptance for new ideas [26] [30] [35] [32]. For example, it took 37 years to for an appropriate journal to recognize and ask Hall to publish a retrospective review on the impact of his unpublished PhD work [27] [28] [34].

Because so much effort is expended on peer review, it has become deified as the gold standard for science, with the dangerous assumption by many that if an article is published in a peer-reviewed journal the content must be true [47].

The vicious socio-economic cycle involving the ever increasing costs to libraries for journal subscriptions noted in 1990 [65] continues to get worse. Editorial peer review became an increasingly important component of ranking and validating submitted papers prior to publication. For journals – especially those conglomerated by commercial publishers – the burdens of reviewing ever increasing proportion of papers that have to be rejected increases costs, and thus subscription prices. By 2000, subscription prices were already dire for research libraries [59] [74] [49] [50]. Today costs are financially untenable even for the largest and most powerful research universities, as exemplified by the recent standoff between Nature Publishing Group (NPG) and the University of California. The University is threatening to cancel many of its subscriptions and to advise its scientists to boycott NPG publications. [72] [58] [15].

Also, as indicated by high profile scandals (which happened even in the era before 1990 [47] [8] [22] [18]), editorial peer review does not detect fraud, error, or plagiarism prompted by pressures on researchers to publish maximally or perish [42] [76] [41] [67] [4]. Consequently, despite the common belief that editorial peer review certifies published claims to knowledge as safe to use, in some cases it spectacularly fails to do this. Nor is the process necessarily fair to those who depend on the publishing and ranking of their papers for academic and professional advancement [54] [1].

Finally, to publish in this paper-based framework, authors often have no option but to surrender copyright on their intellectual work to the publishers, who then effectively control who is allowed to read the work, when, where and at what cost. For example, Hall chose to self-publish an important early paper [30] when the conference publisher required formal permission even for him to reuse his own graphics in his further work. However, if publishers are to stay in business, they have no option but to treat the works in their publications as merchantable commodities. This limits access to that work only to those who can afford sometimes astronomical subscription costs or who have access to holdings and subscriptions of major research libraries not available to academics, professionals and students not associated with premier institutions.

Other than helping editors select content and improve its presentation, does editorial peer review ensure that published knowledge claims are reliable and "safe to use" as a foundation for building further knowledge? We think Bornmann et al's meta-analysis says it all:

We conducted a quantitative content analysis of 46 research studies that examined editors' and referees' criteria for the assessment of manuscripts and their grounds for accepting or rejecting manuscripts. The total of 572 criteria and reasons from the 46 studies could be assigned to nine main areas... None of the criteria or reasons that were assigned to the nine main areas refers to or is related to possible falsification or fabrication of data. [4]: p. 415.

However, despite all these problems, researchers and their employers are still wedded to the idea of the peer-reviewed journal. Is there any value in this cumbersome, costly, time consuming and fallible process?

#### THE EPISTEMOLOGY OF KNOWLEDGE CREATION

Following Karl Popper's evolutionary epistemology [60] [60] [62], as informed by Thomas Kuhn's ideas on social aspects of the growth of scientific knowledge [52] [53], scientific knowledge is built over time through fallible cyclical processes beginning with speculation based on shared knowledge, and progressing through trial, error-elimination, sharing and publishing of results, followed by subsequent rounds of further speculation based on shared knowledge. Understanding how this works in today's world of the academies and professions in an increasingly socio-technical environment is crucial to minimizing problems revolving around our use of publications to support knowledge growth.

We begin by considering what scientific knowledge is and what it is not from a Popperian point of view. Scientists and others may claim to know something scientifically. However, no matter how many tests a claim has survived; it can never be equated to truth (where truth is the complete correctness of a claim about the real world) [60] [61]. Popper argued that although the truth of a belief statement could never be proven, at least universal statements could be deductively falsified by the failure to observe predicted phenomena. However, Duhem, Quine and others argued that falsifications could always be explained away by auxiliary hypotheses as argued by [13] [64] and other papers collected in [39]. In his later work [62], Popper accepted that hypotheses could also never be certainly falsified, but something about the conduct of science still contributes more to the growth of knowledge than do fantasy and belief.

To clarify his thinking about the evolution and growth of knowledge, Popper [62] introduced an ontology of three worlds, as extended by [30] [31] [32] [78]:

- *World 1* (W1 *physical events and processes*) is dynamic physical reality and everything in it, including physiology.
- World 2 (W2 cognition and living knowledge) is the domain of embodied behavior of agents, mental states and psychological processes within minds, dispositional and tacit knowledge. W2 encompasses active processes and subjective results of cognition. Cognition produces knowledge embodied in living things as, "dispositional" or "situational" knowledge (propensities to act in certain ways in response to particular situations). By extension, W2 includes the embodiment of all kinds of cybernetically self-defined and self-regulated dynamic processes. In other words, W2 contains the semantic significance or meaning of cognitive processes and their results in living systems, while the physical dynamics of the matter remain in W1.
- World 3 ("W3" objectively persistent products of knowledge) is the domain of persistently codified knowledge, where encoded content can exist objectively, independent from a knowing entity. Popper defined W3 to include knowledge in the objective sense, which includes

"the world of the logical contents of books, libraries, computer memories, and suchlike" ([62]: p. 74) and "our theories, conjectures, guesses (and, if we like, the logical content of our genetic code)" ([62]: p. 73), while the physical structure of the codified content remains always in W1. W2 mediates between W1 and W3.

Knowledge evolves and grows as claims in W2 are shared via social expression and codification in W3, and strenuously tested against W1. Claims that survive such intersubjective testing are clearly better than those that fail.

Popper [62] summarized his ideas in what he called his "tetradic schema", or more boldly, his "evolutionary theory of knowledge" as detailed in Figure 1) Popper developed his evolutionary epistemology primarily in the context of human cognition. We argue [30] [31] [35] [32] that knowledge is formulated and applied by living systems across several hierarchical levels of organization [55] [69] [70] including living cells, organisms including people, and social and economic organizations [57] [37].



Figure 1. (after [62]: pp. 243).  $P_n$  is a problem situation the living entity faces in the world,  $TS_m$  represent a range of tentative solutions (or theories in self-conscious, articulate individuals) the entity may embody or propose in W2 to solve the problem. *EE* represents a process of "natural" selection imposed by W1 on the entity applying the tentative solution, or a process of criticism and error elimination in W2 that selectively removes those solutions that don't work in practice.  $P_{n+1}$  represents the now changed problem situation remaining after  $P_n$  is solved. As the entity iterates and reiterates the process, it constructs an increasingly accurate representation of external reality.

The knowledge management literature provides many different versions of learning cycles that involve the formulation of ideas, applying them, and attempting to learn from the results to improve knowledge (e.g., SECI [56]; "knowledge life cycle" [16]; double-loop learning [3], etc.). We prefer the terminology associated with John Boyd's OODA loop process [5]. Not only does this have a very robust derivation from the world of military affairs (e.g., [24] [24], but it is the direct practical application of Popper's evolutionary epistemology to building knowledge about real world situations [30] [31] [32] [36] [78]. The OODA loop involves iterated processes of Observation (i.e., collecting sense impressions of the world), Orientation (sense-making, relating observations to prior knowledge, generating tentative solutions, logic testing, planning, etc. [24]), Deciding (selecting a tentative solution), Acting (applying the selected solution/plan to the real world). The next iteration repeats, beginning with observations of the world - including effects of the action.

## SOCIAL CONSTRUCTION OF FORMAL KNOWLEDGE

The production and formalization of scientific knowledge involves social (and increasingly technological) processes at four distinctive levels of dynamic organization (Figure 2), as described in more detail in [78]. From an epistemological point of view these are knowledge building epicycles, respectively termed creation, collaboration, publication and assimilation.

*Creation.* The first cycle involves the cognitive processes of a single scientist ("**T**"), who (1) **O**bserves the world; **O**rients to it in order to make sense of observations in view of (a) his/her knowledge of society's "**B**ody **of Formal Knowledge**", (b) operative paradigm and (c) local group's prior experience of the world; (2) builds **T**entative **T**heories; and then (3) tests them against the real world to **E**liminate Errors, thereby beginning the next cycle with refined ideas. This process may take place tacitly (W2), or it may involve (4) writing down (W3) ideas, observations, theories and tentative conclusions [78].

*Collaboration.* The second (epi-)cycle, that may encompass several instances of the first, begins where the individual investigator may articulate and share ideas among a close group of collaborators, ("WE"), who Observe intersubjectively to one another and further work to eliminate errors (W2). The result of the individual (and optional collaborative work) is to produce a draft paper codifying the individual or joint knowledge claim.



Figure 2 (modified from [78]). Epicyclic construction of scientific knowledge. This involves four distinct levels of organization. "I" – the individual innovator or scientist. "WE" – a group of collaborators working together on a research project or paper. "THEM" – the scholars and journals of a discipline or paradigm within which the project is embedded. "KNOWLEDGE SOCIETY" – the global community of scholars concerned to advance the scientific knowledge of the world and who consume the published and (hopefully) certified products of scientific collaboration.

Publication. In the world of editorial peer review, the third epicycle that may include additional cycles of re-submission begins when an explicit (W3) knowledge claim is submitted to a journal - where most journals today are publication outlets for particular research disciplines generally relating to specific paradigms. As detailed in several papers included in the 1990 symposium [65] and elsewhere, (1) the editor (or editorial staff) reviews the paper. It may be rejected at this point as inappropriate or (2) be forwarded to selected disciplinary peers for review and comment (drawing on their disciplinary knowledge) about relevance of contribution, writing/ presentation, design/conception, method/statistics, discussion of results, reference to the literature and documentation, theory, author's reputation/institutional affiliation, and ethics [4]. (3) Based on reviewer comments and the editor's own decisions, the article is either returned to the author as rejected (with reasons), or with requests or requirements for revision. Because this review cycle focuses on "quality" and "marketability" from the publisher's and paradigmatic points of view, the editorial peer review actually contributes little epistemic value to the content. In fact, as has been noted above, because most reviewers will be scholars within a particular discipline, the process may impede or prevent publication of revolutionary or unifying cross-disciplinary ideas not understood by busy reviewers whose own established beliefs may also be threatened by new ideas. Yet, it is these disruptive or paradigm changing works that potentially offer the greatest epistemic value to the knowledge society.
Assimilation. The fourth epicycle is that which involves the Community of Knowledge as a whole and uses the body of formal knowledge (BoFK) to guide real-world activities and to serve as the foundation for further advances in knowledge. Encouraged by the publishers, many readers assume that the peer review process of formal publication somehow or other certifies the formally published claims to knowledge as being "safe to use". However, as documented above, this assumption is unsafe. Only when other scientists in the community actually assimilate and begin to apply published knowledge in their own investigations of the real world are published knowledge claims genuinely tested. Some published claims are unrepeatable, some are specifically contradicted by further testing, and (unfortunately) some are even shown to be fraudulent.

#### SOCIOTECHNICAL CONSIDERATIONS

Based on material cited here, the existing paper-based paradigm of the peer-reviewed scientific journal is approaching the end of its life as the dominant source of formal knowledge for the scientific community. This is already demonstrated by the physics community where the Internet-based arXive.org [19] has published more than 650,000 articles since it was established in Aug, 1991, and now adds some 6000 articles per month [2] with more than 40,000,000 downloads in 2004 [20].

The arXiv is entirely scientist driven: articles are deposited by researchers when they choose (either before, simultaneous with, or after peer review), and the articles are immediately available to researchers throughout the world. As a pure dissemination system, it operates at a factor of 100–1000 times lower in cost than a conventionally peer-reviewed system [20]: p. 9606.

Publishing to arXive is not totally unconstrained. Screening mechanisms are provided to ensure that submissions meet minimum standards for legibility, organization and author credibility. Some authors are content to publish their work to arXiv and forgo the formal publishing route – depending on citations among the community to rate the paper's importance; but even most articles posted prior to journal submission are still accepted and published in formal journals.

Assuming that most journals will disappear as scientists becomes more used to the capabilities of the Internet technology, what is this technology and what does it offer scientific publishing?

*The Internet*: This is accessible from almost anywhere to almost anywhere, but may be limited by authoritarian regimes. In the developed world, access costs "next to nothing" even to the private individual, and internet access is often bundled with personal communication services.

*Body of Formal Knowledge (BoFK)*: Most current formal knowledge is already indexed and discoverable in seconds via Web tools such as Google Scholar (<u>http://scholar.google.com</u> - free to the Web) or Web of Knowledge ([75] – that requires library subscription). Freely available articles are retrievable in seconds via Google. With an appropriate library subscription, many more articles can also be accessed in seconds via a fusion of Google Scholar and library subscriptions from various subscription-based journal repository servers. Personal experience (as illustrated in the bibliography of this paper) suggests 30-50 percent of relevant articles are already available free-to-the-Web in some form.

*Electronic authoring*: Authors can easily access free or commodity technology such as MS Office's tools, Open Office or the free, HTML-based Google Docs [38].

*Document Repositories*: It is not easy to determine how much document storage capacity is available in public, private and academic repositories. The last moderately authoritative study we have found is [43], but the capacity appears to be growing while the cost per given storage volume decreases. Basically capacity is not an issue, but some concerns need to be addressed: guarantee of continued support or alternatives for existing repositories, redundancy against failures and possible societal upheavals, and ensuring bandwidth of access (an issue in less developed areas of the world.

Publishing and indexing: Without concerns for the kind of quality control and aggregation services provided by journals, "publishing" can be virtually free and instant. Anyone can upload documents to academic repositories or personal web sites in seconds. Google indexes academic sites almost daily, and as soon as the document is indexed it can be retrieved in seconds. Bibliographies link newer work to older sources. Google and Web of Knowledge's citation indexing [21] [23] provides links to more recent work. Such knowledge processing technologies are becoming ever more sophisticated. Processing power, transmission speed and storage capacity per dollar are increasing exponentially at rates approximating 37, 19, and 26 percent per year, respectively - with no evidence that technological limits will be met soon [44] [48] [9]. In this radically changed technological environment for constructing scientific knowledge, we next consider who is a publisher in the new paradigm and what do they do?

*Publishers.* As noted above, nothing now prevents an individual scientist from publishing claims directly to the Web. However, the conventional editorial and publishing activities of selection, quality control and aggregation will probably remain useful. "Publishers" will provide these services, and would seem to require the following functions to achieve these aims:

- Editors to select and monitor reviewers for each submission, track and assess reviews, notify/correspond with authors re editorial requirements, manage publishing process to post article to a formal repository; and
- Reviewer(s) as selected and monitored by editor(s), who know their fields, who are ethical and responsible, and who are prompt.

Costs for such publishers should be minimal. Disciplinary societies may appoint and monitor editors. Academic institutions normally provide editors and reviewers with release time for what is considered meritorious services to a discipline that adds to institutional prestige.

*Preparation for publication.* This task can easily be removed from the publisher. Formats can be standardized at the author level through the strict use of word processing templates or, preferably, working in a structured authoring tool [73] [78] – something that technical communicators have done for a decade [29] [63]. Suitably structured documents can be automatically converted to PDF and HTML.

Assembly and issue of formal document. This will involve little more than supplying "journal" metadata around the approved article and uploading it (i.e., release) to a formal repository indexed by search engines. There will be no costs for printing and physical distribution or production of reprints and maintenance of back copies. Authors will retain copyright under Creative Commons [10].

*Repositories.* Publication will be to one or more established repositories that must be paid for, managed and maintained. Ideally repository costs will be treated as a "social good", e.g., as is the case for the Internet Archive [45], and arXiv [20].

*Residual problems*. As demonstrated, the technological resources for the new paradigm of scientific publishing already exist. There are only a few residual problems:

• Interoperability. Interoperability refers to semantic difficulties converting content across computational platforms [77], but most problems would disappear if the initial authoring was done in controlled and standardized environments. An example of the difficulties is that in

converting between Google Docs' HTML and MS Word's .doc and .docx formats [38].

- Integrity of review process. As noted above, both authors and reviewers can game the peer reviewing process to unethically advance their own causes. Using capabilities of the new technology reviewing can easily and inexpensively be made open and visible to allow the easy identification of such gaming.
- Speed of reviews. Documents can be exchanged at light speed, and there are a variety of inexpensive content management applications that track overdue workflows.
- Who owns/pays for repository services? We think this is a public good that should be supported by the state. The (comparatively minimal) costs could also be covered by disciplinary society memberships or author page charges.
- Legacy documents. How to make legacy documents owned by commercial publishers free is a major issue. Publishers have paid significant costs to scan and make their backfiles on which they hold copyright indexable for electronic retrieval. Understandably, these files are only available to those who have paid to subscribe to the services. We argue that all scientific knowledge should be freely accessible via the internet, and accept that commercial publishers who achieved their ownership of source documents in good faith should be bought out. This is an issue for governments, granting agencies, universities and the research establishment in general to consider.
- *Books*. Books are a different issue from scientific papers. Authors normally expect some return on their huge effort for actually producing a book, with commercial publication representing the normal pathway to achieve this. Where the epistemology of scientific knowledge is concerned, there are also obvious differences between monographs, text books, technical publications, and general literature that are beyond the scope of this paper. However, mechanically, the holdings of major libraries are being scanned by Google [40] [68], and book content is already available on-line or will be so soon with the main issue being how material still in copyright should be handled.
- *Existing publishers*. As well as their roles in quality control and aggregation, existing publishers still have important roles in the distribution of news and commentary. Much work still needs to be done re models (1) for supporting or buying them out and, (2) dealing with the copyright status of scientific works that should properly be freely accessible to the community of knowledge.

#### CONCLUSION

The existing paradigm of paper-based publishing of scientific journals has been made untenable by ever-increasing numbers of papers seeking publication and unrealistic expectations from the editorial peer review processes associated with journal publication. Editorial peer review doesn't certify published knowledge, and is not a good guide as to the eventual value of published content to society. New electronic technology facilitating the expression, circulation, testing, publishing, linking and discovery of knowledge claims supports the development of a much less expensive and far more responsive paradigm for disseminating scientific knowledge. By understanding the four epistemological cycles involved in formalizing knowledge within the knowledge society, creation, collaboration, publication and assimilation, perhaps we can replace paper journals with a better system for supporting the growth of scientific knowledge.

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# Some Thoughts On Peer Review In The Global Internet Context

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#### Abstract

Thoughtful review and comments from interested and knowledgeable persons are more relevant than ever to motivating original thought, disciplined research and progress. This paper argues that conflicts of interest, fragmentation and an emphasis of prestige and exclusivity over knowledge transfer, are driving the traditional journal publication model to well-earned irrelevance and paper extinction. The summarizes issues encountered by the author in aerospace engineering, strategic affairs and community relations, along with evolving trends in capturing knowledge. The implications of internet based peer review are considered in suggesting a model for peer review and cross-disciplinary innovation, with some preliminary empirical observations on needed refinements.

Keywords: Peer Review; Electronic journals

#### I. Introduction

As the title indicates, this paper looks at the issues that are familiar to most researchers regarding the system of peer reviewed publication. It considers what may have changed, and what might change, given the preponderance of the internet in modern human communications and expression. The first part of the paper lays out the reasons why the traditional journal system is in trouble. The second part attempts to lay out a viable alternative.

The topic of peer review has brought out several papers at this conference. Samkin [1] uses a case study approach to document the emotive and perhaps haphazard nature of the academic journal peer review process, and how authors navigate through it today. Mavrofides et al [2], highlighting the continuing search for quality metrics, propose a "reference influence factor" to judge the impact of a given paper. Eichberger and Fachbach [3] assess the process and results of peer review applied to an interdisciplinary symposium on an engineering development problem, using quantitative metrics. A quick survey confirms that the issues run across several disciplines. Examples cited by the authors of Reference [1] discuss issues and solutions from Management[4,5], Economics[6], Law[7], Nursing [8], Nuclear Medicine[9] and other fields [10,11]. The intense feelings regarding the process are evident from some of the titles, despite their appearance in traditional peer-reviewed journals.

Typing the words "peer review" into an internet search engine, and displaying the images that come up, is an easy and illuminating exercise. It is also a dramatic change from just a few years ago, when few researchers would express their thoughts regarding the peer review system in public. A small sampling of the cartoons that come up, gives a good perspective on researchers' opinions. This exercise is best left to the reader, again a luxury that would have been impossible a few years ago. Listing a series of references to the cartoons, or including them in the paper, is superfluous. We will return to other changes brought about by the internet after considering the various issues.

#### Views on Peer Review

Peer review is used in numerous walks of life. wherever honest, interested, competent evaluations of some operation, product or process are desired in order to establish and improve quality. Medical establishments, accounting firms, pharmaceutical developers, nuclear plant operators, aircraft designers, college teachers, research authors and their sponsors, all depend on peer review to establish the quality of their operations. The West Virginia University library [12] provides a useful working description of peer-reviewed journals, including the purpose of peer review and the expectation of depth. Their definition cites the expertise of reviewers in the field, as well as the expectations that articles are written by researchers or scholars in the field of the journal, contribution of new information to the field, and the purpose of sharing results of original research with the rest of the "scholarly world". Use of citations of bibliographies footnotes, or and technical terminology presume that readers have backgrounds in the same field.

#### The Reviewing Problem

To understand why good reviewing is such a precious asset, consider what is involved. A conscientious reviewer treats reviewing as a professional obligation to be carried out in a timely manner to the best of one's abilities, making time regardless of reward or hostility. The process for a submitted paper and for an onsite presentation are similar except for reviewer anonymity. Good reviewing takes multiple readings, searching (in both mental and physical archives) for related prior work and context, analyzing the conclusions against the results, and carefully framing questions before arriving at summary recommendations. A good peer review should thus engage the brains of the authors and the editors. People who put this level of thought and effort into such an invisible assignment, are far fewer than submitted papers.

### **II. Issues With Traditional Peer Review Model**

### GroupThink

The U. Nevada library's definition of a peer reviewed journal [13] triggers some thinking and arguments. This is in no way to be taken as criticism, but instead points to that resource as accurately summarizing accepted views of most people today regarding peer-reviewed journals. Some issues triggered by their definition are:

- 1. Author credentials as criteria for acceptance
- 2. Assumption of a narrow audience
- 3. Publication as certificate of quality
- 4. Reviewer credentials as proof of validity
- 5. Assumption that researchers who review are also scholarly enough to have perspective beyond their areas of specialization.

Saffman [14], points out that "one cannot be a researcher and a scholar at the same time". His reference is to the researcher's focus on narrow depth versus the perspective expected of a scholar. A particularly entertaining example is the Religion in South Asia (RISA) group of the American Academy of Religion [15]. Dominated by PhDs and grand-PhDs emanating from one group at a particular Divinity School [16,17], this group was notorious for shutting out participation even by accomplished senior professors in their own discipline. Posts by questioning practitioners however lucid or expert, were censored as not coming from academics. Posts by academics were mysteriously "lost" due to "computer error". They then felt compelled to bestow their wisdom on all through the open internet, describing themselves with no trace of shyness as "scholars". Several turned out to be graduate students or post-doctoral

fellows. Predictably, they generated so much laughter that they decided to shield their scholarly deliberations from the outside world, and led to the notice displayed at their "archives" site when last viewed. This example is illustrative because the group exemplified all 8 symptoms of GroupThink[18], and suffered a shock to the first – the Illusion of Invulnerability. Sadly, similar symptoms are exhibited by other groups of older, though no wiser, "experts" in many fields.

# **Conflicts of Interest**

Conflicts of interest are distressingly common in the peer review process. The dual role of quality control and motivation entrusted to journal editors and reviewers, encounters conflicts of interest, especially when there are underlying competitive aspects and financial pressures. The picture is the same, whether in engineering or pharmaceuticals. In the "Science 1" disciplines, conflicts may have more to do with priority and fame, also leading to large grants. In engineering, it may have more to do with funding for particular organizations, and the urge to keep competing concepts or organizations from getting ahead. Where the associate editors are themselves competing to solve the same problems, and the reviewers may be consultants hired by the editors' organizations, the author with the potentially "disruptive" paper is at a hopeless disadvantage - a situation encountered all too commonly in the flagship journals of aerospace engineering. Several techniques used in "killing" or "sliding in" a paper are listed below.

- 1. **Delay:** Most journals swear by the dictum that "timeliness is the essence of fairness"[19], but this is of little comfort to authors made to wait longer than the average human gestation period for the first reviews.
- 2. **Dismissive rejection or glowing acceptance:** While uncritical acceptance of work agreeing with one's own conclusions is a conflict of interest, a very destructive technique is the short, dismissive rejection with the deterrent declaration that the reviewer is an authority on the field, implying that seeking the reasons would only prove the author's ignorance.
- 3. Unusually harsh or mild comments: Likewise, a 4-page diatribe against a paper may deter even the editor's intentions to read and understand. The American Helicopter Society Journal achieved uniqueness in the late 1990s by deleting all (including the primary corresponding) authors except the government author of a paper and then publishing a "correction" front page with the authors' names in the next issue. At the other extreme

is uncritical commendation. More than one journal in the aerospace field have featured articles from the editors' organizations or immediate social circles in practically every issue for several years, with little indication of objective reviewing.

- 4. **Demand for "additional work":** A tactic used to deter or indefinitely delay publication of a competitor's work, this might be framed as a minimal requirement for acceptance.
- 5. "Re-Review" following rebuttal: Rather than considering an author's detailed rebuttal demolishing a negative review, an editor may send the paper to a completely new reviewer for a "Re-Review", conveying to the new reviewer that the pesky author refuses to go away after 14 months. Can the choice of such a reviewer be better than the original choice? A second and "final" rejection is guaranteed, especially with the new reviewer full of pride at being picked by the editor as an "authority".

Reviewers are anonymous (which is essential) and do not have to defend their (in)actions (which is a problem). The most egregious abuses lead to nothing worse than a hesitation to send any more papers – until the desperate search for "expert" reviewers makes the editor forget. Editors can delay publication indefinitely. The case of the 14month delay mentioned above is by no means exceptional. Competent reviewers are hard to find – and are usually competitors. From all this, one concludes that *it is not possible in the traditional peer reviewed publication model to eliminate conflicts of interest.* 

**III. Extinction of the Traditional Journal Model** The above discussion leads to the proposition that the traditional model of submit, review, rebut, revise, proofread and only then publish, in media controlled by professional organizations or commercial publishing houses, is on a trajectory to extinction. Several indicators are listed below.

- 1. Adversarial / arrogant attitude: The basic assumption of the term "refereed publication" is of an adversarial relationship between the author and the reviewer, with the Editor serving as the unbiased Referee. This model ignores the basic fact that the intellectual property and the contribution are those of the authors, and that people read the journal for the author's work, not to admire the publisher or the editor.
- 2. **Poor value addition by sloppy reviewing:** Given the stated purposes of peer review,

authors have to wonder about the value added if there is no intelligent discussion.

- 3. **Cost ("paper charges").** Many journals demand money to publish papers. One must wonder why this should be acceptable to any author, beyond the obvious publish-or-perish pressures of the academic tenure track.
- 4. **Delay:** This is nearly always due to the poor work ethic of the editors and the reviewers. One Chief Editor of one of the aerospace journals mentioned before, sagely advised in the 1990s when asked about two long-pending papers, that in his vast experience, delayed reviews are usually due to the paper being bad. Counseled in return to get his office in order and call back when he had a better clue about his job, he accepted both papers with admirable alacrity.
- 5. **Poor visibility:** Most institutional libraries are under financial pressures. Far from subscribing to new journals, they are constantly seeking to cut back on subscriptions to existing ones.
- 6. Misses the Search Engine Audience: Many journals (belatedly) do allow titles and abstracts to be found on the internet, but expecting searchers to then pay for the full text is not usually realistic, if one remembers that they also extract hefty publication charges from the authors. Access through institutional libraries is a partial solution, but in this author's opinion, it is also a temporary one given the same library budget problem. Citations will be more numerous on papers that are accessible, and this will sooner or later induce authors to seek publication where the full text can be accessed free of cost, by new authors. Since the above journal models offer absolutely no financial incentive to the authors (or reviewers, for that matter) authors have no motivation other than perceived "prestige" or fear, to keep subsidizing publishing houses with their intellectual effort. They then risk having their work ignored by citations in favor of later, but openly-accessible work by others.
- 7. Evolving Reader Habits: The present generation coming up through college grew up with the internet. They ignore linear or hierarchial methods of organizing knowledge. Their test of relevance is whether something shows on the first few search engine screens.
- 8. **Casual adoption of technology** in review systems poses its own problems. Electronic submission and web-based access for reviewers are convenient and eliminate much of the effort of printing and mailing reviews. However, these conveniences also do the

disservice of conveying the false impression that a review has been done, and make it far too easy to "fake" a review.

- 9. Universities are relying more on "prestige" criteria in promotion/tenure decisions. The primary support for the traditional paper journals comes from the fear and pressure induced by academic promotion/tenure processes among researchers and faculty. Today, every faculty member appears to be under pressure to be described as being among the "top three" in their field. By conventional definitions, this would result in a drastic reduction in the number of faculty in any given field. The solution is to narrow the field enough, and limit the scope of a journal enough to ensure apparent uniqueness.
- 10. Fragmentation and proliferation of journals inhibits cross-disciplinary innovation. The solution adopted by specialist communities to the lack of competent "expert" reviewers in their narrow fields, is to create ever - tighter peer circles. This leads to fragmentation of knowledge and "inbreeding" of research communities who have strong interests in keeping the circle tight. Library budget constraints then lead to an interesting effect of the prestige chase: *The most "prestigious" publications may be so exclusive that few can even find them.* This route destroys crossdisciplinary knowledge dissemination.
- 11. Academic freedom vs. responsible behavior: Most researchers and faculty treasure academic freedom, and would attack any and all attempts to abridge this freedom on any account whatsoever. However, academic freedom is most endangered from within, by egregious behavior that does not stand up to any reasonable examination of motives, competence or ethics. Examples of abuses abound. The RISA example arose when knowledgeable community practitioners sought to reasonably rebut [20] outrageous "scholarship" bordering on criminality [21]. Scholarly communities that do not welcome and facilitate well-reasoned disagreement from "lay persons", are not worthy of respect. Knowledgeable community members shut out of so-called "scholarly journals" form their own responses" [22-24], arguably reaching far more readers than the journals do.

### **IV. So Why Have Peer Review?**

Thoughtful review and comments from interested and knowledgeable persons are more relevant than ever to motivating original thought, disciplined research and progress. In brief, they

- Help set in context of prior work
- Ask questions that clarify the author's thinking, calculation, presentation and writing
- Catch errors
- Facilitate rebuttals, revisions and explanations
- Increase utility to other readers through an open discussion of important issues.

This list does not include the commonly-assumed purpose of "Accept only High-Quality Papers". Some process for rejection is essential, if only to encourage other authors to devote their best efforts. A high rejection rate however, is a low-quality metric of quality. The journal's responsibility to not publish nonsense must be weighed carefully against the risk of rejecting innovative work. There are better ways to ensure quality, as discussed later.

# V. Technological capabilities and evolving trends in capturing knowledge from prior work

The key to solving many of the issues with the traditional journal system, is to remove the power to obstruct publication, without removing the power to pose countering facts and opinions. The function of protecting the public from wrong theories, data or results through censorship, must be given up and replaced with the function of presenting competing views and letting the reader make informed decisions. Internet Search Engines brought about a continuing revolution in access to knowledge. In the 1990s, we spent considerable effort conceptualizing how to guide learners towards the most appropriate resources. Our efforts were swiftly overtaken and rendered irrelevant as users adapted intelligently to the endless possibilities of Search engines, and the engines themselves improved immensely in speed and accuracy of finding relevant material. Resources such as "Google Books" and "Google Scholar" have done much to rebut the irrational disdain of "scholars" for internet-based publication. Delivery to personal communication devices such as ereaders broadens access by another order of magnitude. The internet is global, and even automatic language translation is routine.

One relevant technical innovation is the moderated discussion forum, where moderation involves active, thoughtful participation of knowledgeable entities, not to be confused with the largely obscene "discussions" at most news sites. Many scientific communities and weblogs already have formalized "list-serve" discussions where posts appear after moderation. Examples of vibrant

discussion for amay be found in the Strategic Discussions community. The distinguishing features here include (a) an accountable email address to join, (b) well-guarded privacy of postors, (c) clearly stated scope of the forum and of individual threads, (d) freedom to post and have entire new threads appear immediately without moderator approval, (e) freedom to edit one's own posts, and (f) a system where moderators may edit, move, delete posts and threads, warn, discuss and ban users where they perceive the need. It is dangerous for any postor to assume any knowledge of other postors' age, nationality, location, occupation, or experience. This makes for exceptionally demanding debates, where opinions must stand or fall on logic and facts alone. The usual descent into personal attacks on the mainstream media sites, is actively deterred by the moderators. Such a forum is unmatched for knowledge value, intellectual challenge and indeed for learning experience on debating skills, when the audience is truly global and broad-based in opinion and experience.

#### VI. Open, Two-Stage Peer Review

How can the best features of the above be captured in journal peer review? Table 1 summarizes a proposed model for cross-disciplinary publication, based on experience with peer-reviewed Strategic Studies journal experience. From [25] comes a discussion of the process adopted by the Journal of Atmospheric Chemistry and Physics. Features are a rapid "access review" stage before immediate internet publication, enabling an 8-week interactive discussion with comments archived and citable. Designated reviewers may remain anonymous, but other commenters are identified. In stage 2, the traditional manuscript review process occurs before publication in the main journal. The model proposed in Table 1 would not require that other comments be signed, but all are subject to moderation for civilized discourse.

#### Preliminary empirical observations

The primary challenge in this system is in motivating experts to participate. Social-media aspects may be a way to motivate, as seen from strategic affairs discussions, a forum on Space Solar Power, and the recent Gulf of Mexico oil spill, all of which bring out knowledgeable albeit anonymous persons along with a crowd of casual participants. Most engineering journals, however, are not likely to generate many comments from readers. Getting authors to submit articles requires recognition and assurance of the quality control processes and archival endurance of the "journal". Both are tough issues to ensure. Given the low to zero cost of publication, however, authors are able to get their articles cited and mirrored by multiple sites, with the original reference citation included in the article.

| I ublication wroaci        |                         |  |
|----------------------------|-------------------------|--|
| Model                      | Rationale               |  |
| Web-based journal with     | Archival, with swift    |  |
| periodical volume and      | global search enabled   |  |
| date identifiers           |                         |  |
| Submitted on-line in       | Possible hardcopy       |  |
| specified format           | publication             |  |
| Editor assigns 3           | Editor can reject, and  |  |
| anonymous reviewers        | reviews come from       |  |
| anywhere in the world      | several perspectives.   |  |
| Article posted on-line for | No censorship, but      |  |
| comments and response.     | comments moderated.     |  |
| Anonymous review           | Encourages reviewers    |  |
| comments sent to author    | to help author improve  |  |
| with time to modify or     | article without penalty |  |
| withdraw article           |                         |  |
| Remaining debate           | Main quality control;   |  |
| published with article.    | Archival reader sees    |  |
|                            | discussion.             |  |
| Further comments           | Provides closure in a   |  |
| published as new.          | reasonable time.        |  |

 Table 1: Proposed Cross-Disciplinary

 Publication Model

Strong moderation is required, especially as author ego is a problem with many authors unused to social media. While such media are excellent in stripping the "credentials" cover from opinions, thoughtless comments can discourage participation by people who expect somewhat deeper discussion. However, one can safely say from experience that such problems are no less or more in social media than in august gatherings of international experts. The Journal of Atmospheric Science reports an excellent "impact factor" for their articles, and points out that their system "deters submission of low-quality papers", thereby achieving a low rejection rate along with the high impact factor. This is an encouraging sign that open publication with peer review and discussion can provide a solution to many of the problems with today's journals. Some remaining issues are discussed in Reference [26].

#### **VII.** Conclusions

- 1. The purpose of peer review should be carefully re-emphasized
- 2. Abuses cannot be avoided with traditional paper journal review system

- 3. Evolving technology and habits, and the fragmentation of time that many experts face, have driven traditional peer reviewed paper journals to the verge of irrelevance.
- 4. Swift and unobstructed publication is essential.
- 5. Open but moderated, interactive discussion provides good quality.
- 6. Archiving reviews and rebuttal is a good experiment.
- 7. Motivating participation and ensuring archival endurance require thought and resources.

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# **Unified View of Arts and Conventional and Systems Sciences**

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#### ABSTRACT

The idea of 'means with meaning' is introduced as the 'things which stand for other things' developed by living, in particular human, beings over many thousands of years for communication and representation of parts of the world. Means with meaning are seen to consist of 'related elements' which together are organised into 'schemes of domain knowledge'. These schemes have the same structure irrespective of the domain knowledge to which they are applied, thus, providing a unified view of arts, conventional and systems sciences.

**Keywords**: Means with Meaning, Representation, Schemes of Domain Knowledge.

#### 1. INTRODUCTION

The world at large exhibits an immense diversity and variety of concrete, abstract, imaginary and symbolic things in static and dynamic state. Living things in particular human beings, have been trying to understand and to find their way in this diversity and variety by creating means of communication and representation leading possibly to prediction of events in the future. This is possible by making 'statements' of the 'subject – predicate' form of varying complexity using the appropriate symbolic things. Representations or 'intellectual efforts' range from drawings by primitive cave man to major artistic works such as those of Michelangelo or from creating an algebraic formula for describing the floor area of a room to major theoretical works like those of Newton, Maxwell or Einstein.

Creation of any intellectual effort requires ingenuity, creativity, perception, talent, knowledge and physical and intellectual ability in varying degrees depending on the particular effort. There is an immense range of products of this kind of creation driven possibly by the need to communicate thoughts and ideas and by an urge for producing representations or images of parts of the world for their better understanding. For the moment, the results of this creative activity are the large variety of arts and sciences with a range of end products, methods and means of achieving them and modes of thought.

However, we may be able to see a common pattern called 'scheme of domain knowledge' which is pervasive throughout all activities. Such a scheme suggests specific constituents and a framework for thinking of how intellectual efforts appear to be constructed. It stimulates the development of knowledge in particular domains and shows a unified view of how works of arts, conventional and systems (or science 2) sciences are developed [1], [2], [3]. A continuity of arts and sciences may be seen to have appeared. Particular aspects of superstition and expressions of everyday opinions and beliefs also appear to be constructed along the lines suggested by the scheme. The aims of this paper are:

1. To introduce a unified view of arts and conventional and systems sciences by showing how the common thread i.e. 'schemes of domain knowledge' are constructed, and

2. To demonstrate how systems science or 'science 2' as understood in [2], [3] etc. fits into the general pattern of 'schemes' supporting the unified view.

#### 2. MEANS WITH MEANING

The following statements, based on observation and generalisation, lead into the concept of 'means with meaning'.

REMARK 1. 'Theoretically we can make an infinite number of statements of the 'subject – predicate' form [4] about any part of the world. Complete knowledge is thus impossible. In practice we are satisfied with one or a few statements which are contingent on a situation and selected by a point of view of an observer and called 'model''.

REMARK 2. 'Because of the immense diversity and variety of parts of the world, it is impossible to match each instance of this diversity and variety that existed in the past, exists now and will exist in the future to a range of forms of 'symbolism' selected from the symbolic things which is necessary for creating statements.

Even simple worlds of living beings require symbolic means. For example, a male deer makes a territorial claim (part of the world) by depositing samples of urine (means with attached meaning intelligible to other deer). Accordingly, human and other beings have introduced 'things which stand for classes of other things' which are selected so as to reflect common features of things in a class. Thus, an abbreviation is introduced as 'means with meaning' (mwm) or 'symbolic things'. The objective of developing mwm is to enable conscious beings to have means for carrying the 'subject-predicate form'. Mwm stand for concepts or abstractions of varying degree. Such concepts can be fixed and, in some cases manipulated, in the brain forming the mind [5].

REMARK 3. 'Any part of the world can be seen as 'related properties or objects in static or dynamic state' forming a whole [2]. An mwm as part of the diversity and variety can be constructed from 'elements related in a specific way'. For example, a word in natural language is constructed from letters of the alphabet so as to acquire meaning showing features of complexity and hierarchy.

Using mwm and related elements, simple and complex empirical models or theories can be developed. Or an mwm can be cast into a 'scheme of domain knowledge'.

An element is a chosen basic part which an observer uses to construct an mwm. An mwm consists of 'elements in relationships' constructed until the mwm becomes meaningful. For example, we can say that the symbol, the word 'mile' as a 'whole' is meaningful. It is a unit of distance, constructed from elements called 'letters of the alphabet' arranged in relations. The word has acquired its meaning as its 'emergent property' from the meaning of its constituents and their arrangement. Using the same elements but changing the relations we arrive at 'lime' which is also meaningful, it refers to a 'tropical citrus tree'. Changing an element affects meaning, for example, changing the letter 'n' to 'm' in 'snug' leads to 'smug'. In general, the construction of complex wholes takes place by nature (tree, zebra), manually (painting), theoretically or by convention (symbol) or by manufacture (artefacts and systems).

A single letter can be seen as an ordered arrangement of geometrical and material properties. Thus, in this example we note a limited hierarchy of: 'concrete properties', 'letters' and 'words'. We can say that things seen to consist of ordered arrangements of other things is called 'complexity' and the arrangement of things is referred to as 'hierarchy' which together is called the 'systemic view'.

Examples of mwm that have been invented over the past millennia by human beings as 'patterns' which can be carried in the mind, are:

<u>Ancient/current methods:</u> 1. Heated bones, flight of birds, omens, portents, astrology, palmistry and so on,

<u>Images:</u> 2. Pictures, sculptures, diagrams, gestures, dances, earth tremors, clouds, variety of signs like road signs, icons and indexes,

<u>Symbols:</u> 3. Natural language (letters, words, sentences), 4. Music (musical signs, tunes, rhythm), 5. Mathematics (numbers, letters, relations).

Following the mwm designated by numerals, human intellectual activities have correspondingly evolved into: 1. Superstitions, 2. Fine and performing arts, 3. Literature, 4. Music, and 5. Conventional science, and their combinations like 'ballet'. The historical development of mwm reflects the intellectual development of humanity.

#### 3. DEVELOPMENT OF SCHEMES OF DOMAIN KNOWLEDGE

We need to propose:

REMARK 4. 'Mwm play a part in turning an experience or view of parts of the world in a domain into domain knowledge. Mwm are the 'means' which are at the disposal of living, in particular, human beings to accomplish this task'.

REMARK 5. 'Elements are used for the construction of either a representation (domain knowledge) or an mwm itself'. For example, 'mechanics' is an empirical domain, 'mathematics' is an mwm.

# Models and information

The idea of 'things which stand for other things' or means of interpretation or means with meaning are used for:

1. Representation of parts of the world or models,

2. Conveying messages about parts of the world or information.

An mwm is encoded in a 'medium' which creates the physical effect by impinging on organs of perception.

An mwm is defined as information when used for carrying messages. Medium + information flow is called the 'informatic product' just like medium + energy flow is called 'energetic product' [6].

For example, in the sentence 'boy should loudly to his friend (model with dynamic verb with adverb implying medium of 'air for carrying sound') to his friend that the ice cream van is coming (subordinate clause carrying information)'. Adverb and information qualify the dynamic verb [6].

#### Use of elements of mwm

A 'domain' comprises parts of the world with shared features. We can have domains:

1. Invented by living objects such as the 'domains of means with meaning' which can be defined such as 'geometry', and 2. Discovered by living things, the 'empirical domains' which

can be initially recognised intuitively such as 'mechanics', 'electricity' and 'thermodynamics'.

In order to cope with parts of the world when confronted with the need expressed in REMARKS 1., 2. and 3., living objects have devised a few basic 'elements' which are used for contributing to the construction of 'schemes of domain knowledge'. This approach brings about the required economy when dealing with parts of the world. Mwm are also used for creating order by classifying objects and for describing 'transfer statements' used for carrying observed parts of the world, 'empirical objects', in an empirical domain, into a model and vice versa for experimentation. This is done by moulding parts of the world, usually simplified, in a domain to fit a theory or to create 'theoretical objects'. Conventional science can be seen as a collection of many domains or disciplines. We can, thus, construct the following 'schemes of domain knowledge' as examples of 'empirical' and 'mwm' domains:

Example 1:

1. Empirical domain: People are selected for their faces to be represented,

2. Chosen means with meaning: Portrait,

3. Elements: Lines, colours put together until a portrait is judged to be completed or recognised,

4. Transfer statements: Faces are perceived by painter,

5. Model with meaning facilitated by inductive generalisations: Portrait acquires resemblance leading to statement 'This portrait is a faithful representation of X',

6. Complex model: Portraits of a group like 'members of a team'.

We note that a hierarchical feature is shown, for example, by Van Gogh's self-portrait which consists of patches made up of elements and the patches are put together into relationships to make up a portrait. Also, elements are assembled into a model to produce an outcome: 'meaning', an instance of the systemic view.

Example 2:

1. Empirical domain: Dynamic mechanical things are selected as the subject of interest,

2. Chosen means with meaning: Mathematics,

3. Elements: Material, geometric and energetic properties i.e. position, momentum, speed, force, acceleration,

4. Transfer statements: For example, a 'railway carriage', a material body, does not rotate, each of its parts moves with same speed along a line thus it can be seen as 'mass particle', a theoretical object,

5. Models with meaning facilitated by inductive generalisations: force/acceleration = mass particle, force/speed = friction and so on,

6. Complex model: mass x accel + friction x speed = total force.

#### Example 3:

- 1. Domain of means with meaning: Music,
- 2. Chosen means with meaning: Musical signs,
- 3. Elements: Horizontal lines, blobs, lines, flags,
- 4. Transfer statements: none,
- 5. Models with meaning facilitated by inductive generalisations:
- Blobs, lines, flags, horizontal lines joined to produce a tune,
- 6. Complex models: Musical score for a song.

We note that 'complex models' are produced by practical or theoretical means such as forming groups or using graph topology for putting together network elements. Also, in domain knowledge of conventional science properties of parts of the world are used for constructing theoretical constructs directly as seen in Example 2. without intermediaries like 'flight of birds' which was a major advance of early science in the 1600's.

Example 2. of scheme of domain knowledge is an example of SCIENCE 1. We can now demonstrate how to construct the scheme of domain knowledge for SCIENCE 2 using [2], [3], [6] in which we introduce:

BASIC NOTIONS: A. Notion of property, B. Notion of object, C. Notion of relation, D. Notion of interaction and impression, and

SYMBOLISM: I. Natural language, II. Building blocks, III. Qualifiers and anticipating further developments of concepts.

#### Example 4:

1. Empirical domain: Objects as classified in the INTRODUCTION,

2. Chosen means with meaning: Language qualified by mathematics,

3. Elements: Properties, relations, interactions and impressions (as in BASIC NOTIONS),

4. Transfer statements: Objects qualified so as to fit into 'chosen means with meaning and elements for preparation of models with meaning'. Theoretical object is called a 'noun

phrase' of proper, abstract, collective and common nouns playing situation dependent parts (man dressed in black striped suit, sits at his desk, <u>interested in making money</u>, (may manipulate shares in the stock market), man dressed in pyjamas, unshaven, <u>hungry</u>, (may prepare his breakfast),

5. Models with meaning facilitated by inductive generalisations: One- and two- place sentences (as in SYMBOLISM) organised into ordered pairs and dynamic sentences,

6. Complex model: Sets of Cartesian products of ordered pairs (STATIC LM) and Semantic diagrams of dynamic sentences (DYNAMIC LM).

#### 4. CONCLUSIONS

We have demonstrated how diverse 'intellectual efforts' can be fitted into the same pattern. This suggests the possibility of a unified view of all such efforts: superstitions, arts and conventional science. In addition, the practice of 'schemes of domain knowledge' may bring into existence unexpected knowledge. We have also shown how 'systems science' fits into the pattern suggesting a continuity of science and demonstrates that it is an 'intellectual effort' which is part of other such efforts. In general, in a scheme of domain knowledge objects define a domain and elements are used to create meaningful models which in turn may lead to complex models or inferential engines.

Although we have shown how preparation of domain knowledge can be seen as a pattern, we emphasise the varying degree of ingenuity, creativity, perception, talent, dedication and physical and intellectual ability which are required for the preparation.

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# **Decision Support Systems Engineering Applied to Editorial Decisions**

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#### ABSTRACT

Peer review is an important issue in the process of evaluation and selection of scientific materials for the purpose of publication in any conference or journal. Although incorporating such mechanism in principle may carry several merits as well as demerits.

We may also optimize the methodology of peer review implementing some of theme of evolutionary algorithm to avoid any chance of individual bias. An effort has been made to design such an editorial decision system to support this methodology.

**Keywords**: Editorial Decision, Process of Evaluation, Evolutionary Algorithm and Individual Bias.

#### **1. INTRODUCTION**

Professional regulation in terms of literary performance is evaluated for its standard and novelty to improve its further prospects by employing the process of peer review. Ideally the review procedures should have certain criteria that must always be exercised to govern their frame. As many as possible, authors (participants) should get an opportunity to express their ideas may it be raw at a glance, in their respective field of science and technology. It ensures a large and diverse collection of ideas, which probably may sometimes carry some high level innovation by chance. It is also essential that authors contributing multiple papers to a journal or a conference at a time must be given a chance to avoid any disappointment and to carry out their enthusiasm for future productivity. Random selection of papers is the one way to ensure a wide coverage or variety of papers accumulating all forms, frames and stages of thoughts. The next strategy should certainly, be the selection of papers on quality basis. The quality control should be observed right in the ]beginning and also at the final stage of review and screening.

There has to be an instrument to motivate authors in order to improve their material in light of suggestions given by the reviewers. The panel of reviewers needs to be configured from time tio time through a regular reshuffling mechanism as to avoid any confounding effect.

#### 2. EXISTING PEER REVIEW SYSTEM

Peer review process follows a critical inspection of the literary works especially belonging to the same area of work. It is even quite difficult for authors and researchers to spot out every mistake in the complicated piece of work. Showing work to others increases the probability of getting the weaknesses identified and hence the chances can be there to get the performance be improved. It is true that reviewing the same paper by a number of reviewers [1], used to be done by the journal editor couldn't solve the disagreement problem. Clinical peer review [2] also refers to secondary rating of clinical values of the articles. Professional peer [3] review focuses on professional performances in different fields of science, technology, law and literature with a view of improving quality, upholdinrg standards and providing certification. The sole power of distributing work of the scholars typically falls to editors [4] hand for selecting referees to check their manuscript. The extra-editorial effort using double masked process [5] has certain limitations as it is confined to a particular research

stream. But such double masked review performs to generate a better perception t[6] of fairness and equality in global scientific environment. It is also true that peer review used to suppress [7] the themes of mainstream theories due to their own cosntradictions. It is in fact true that scientific editorial systems [8] aren't the hostile of new inventions and discoveries. Also it has been found that lack of accountability in such review process may lead to reflect it as a biased and inconsistent procedure [9]. Many high quality journals initially started a hybrid peer review system [10], incorporating open peer review with blind reviewing process, later such system not sustained longer [11]. In past times established editors were given more freedom of discretion, but opposing a new proposed idea [12] was not an easier approach without any established ground. Although peer review process shows strength and weakness [13] at various levels, pernicious publication practices [14] are very common and negative review [15] has its own importance in checking standard of publication in vital fields.

#### 3. ASSUMPTIONS FOR DESIGNING DECESION

#### SUPPORT SYSTEM

Relaxed evaluation criteria may result into rejection of some high quality papers due to a permissible level of randomness in selection process. Moreover the selection of low quality papers may also decline the growth performance or outcome of any journal. So keeping both the ideas of quantity and quality level assessment approach may provide a better evaluation tactics that reflects a cumulative approach in making an unbiased judgement considering all associated vital dimensions at a time to give better results in real terms regarding paper selection paradigm.

#### 4. PROPOSED DECESION SUPPORT SYSTEM

A decision support system can be devised which may definitely be of help in conducting the selection process keeping a certain sort of algorithm in mind. Such decision support system framed to take decision on the basis of certain fixed parameters, would take into consideration a basic doctrine of collective laws that will have an influential impact over the sole decision. The support system allows all sorts of constraints in its model to attain an optimized form for evaluating a set of boundary conditions which helps to retain its predefined framework. There would be various components of decision support system mostly keeping in view that some may be flexible while others are rigid, that will collectively decide on behalf of incorporated testing information and having implicit role in making any such unitary decision.

#### 4.1 Decision Support System: Design

A schematic model outline, comprised of few indispensable steps is shown in the **figure 1**,



Figure 1. Units of Decision Support System

#### 4.2 Decision Support System: Working

All the configured components of a decision are made working with certain heuristic algorithm to generate binary response or decision in absolute terms after following a few step computationally configured dynamic unit execution path.

Random selection operation pertains to Monte-Carlo based generation of random numbers with a set of trials to allow more or less even distribution of chances for the considered individuals to get selected.

The screening or processing layer implies the implementation of evolutionary algorithm to ensure the selection of most developed and novel ideas in the screening process.

A large initial database, just obtained from a sole pool of papers at the forth most raw stage, which ensures to have a variety of information. Submission of multiple papers should give emphasis in order to maximize the selection probability.

The theme of mixing and amalgamation of similar and dissimilar ideas particularly innovative and novel themes probably give a better framework of scientific analysis and decision preface.

The selected papers on this background will be allowed to go into a rigid selection criteria which will be applied taking in view the robust and updated knowledge in the specific field.

The rigid selection criteria is required to design in such a way that precision based inference may be drawn from the obtained score for a given manuscript. Simply summation of assumed weights and their multiple with a certain factor weight (defined for the taken area of research) would be proved quite effective to find a value in terms of scoring function.

The above **equation 1**, shows the summation of the product of 'X' marks and the corresponding weights 'w' in the respective area together with factor weight fw which is derived from the scoring process of other similar manuscripts. So using such scoring function we may even evaluate each 'i-th' individual section of the manuscript accordingly by the referees in a particular area. Using this theme of mathematical ground the level of biasness can be minimized to a greater degree indeed.

The final selection can be made using the general concept of test of significance. The statistical view would definately refine the rejection and acceptance criteria in a instrumental manner. The general knowledge base of large number of area specific cases might be helpful to draw any such conclusion from population and sample mean of score obtained by the papers and hence a test for required *p*-value can be performed.

#### 5. CONCLUSIONS

Paper with innovative ideas should be weighed over a well written manuscript. It is evident that rejection of innovative ideas is one of the weaknesses of peer reviewing. The heuristics based method appeals the amalgamation of randomness property with general statistical view. So such a way of sampling really has great advantage in presenting the feature of large data base with small sampled patch of retrieved data. The two step screening with different degree of relaxation criteria in our devised algorithm would be helpful in making the operation coverage to a greater extent. All such new ideas may prove to be one of the precious steps in going towards the inventory goal.

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# Improving the peer review process: an examination of commonalities between scholarly societies and knowledge networks

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#### ABSTRACT

Whilst peer review is the common form of scholarly refereeing, there are many differing aspects to this process. There is a view that the system is not without it's faults and this has given rise to increasing discussion and examination of the process as a whole. Since the importance of peer review is based on the primary way in which quality control is asserted within the academic world, the concern is what impact this is having on an ever increasing diversity of scholarship, in particular, within and between science and engineering disciplines. The peer review process as is commonly understood is increasingly considered as a conservative approach which is failing to adequately deal with the challenges of assessing interdisciplinary research, publications and outputs.

**Keywords**: community of interest, community of practice, Scholarly societies, interdisciplinary research, knowledge networks.

## **1. INTRODUCTION**

The peer review is still regarded as a useful editorial gateway for assessing the quality of scholarship, and creating a form of formal record, but is far from being a foolproof process. With regards to the review process experienced through an interdisciplinary and/or hybrid discipline (where the topics discussed do not comfortably align with established discourse), the process can often produce a split outcome where by opposing feeding back loops battle to claim the emergent concepts being put forward. In these cases, the process of double blind peer review is only useful if there are more than two reviewers. Whilst the author may be requested to submit again, this does not exclude a split outcome to re-occur. This "split outcome" experience has been observed to ocur with (some) regularity where the concepts lie between paradigms. The difficultly of obtaining positive reviews early on in the process would apply in particular to difficult work and/or in emergent fields [9].

This paper examines recent literature reviews that have been carried out regarding the role of peer review in

scholarly societies and commonalities that can be drawn between knowledge-based organizations and communities of practice behaviour (as they are both membership based groups). The importance of the similarities displayed between scholarly societies and communities of practice, features capabilities that are common and fundamental to building sustainable economic, social and learning network systems. Examining the aspects of both scholarly societies and knowledge networks may increase our understanding as to what scholarly societies could offer for interdisciplinary or emergent scholarship peer review.

The peer review process whilst having its critics is still regarded as the traditional form of assessment. The difficulty then lies in examining what other ways may be used or incorporated to better serve emergent interdisciplinary and/or hybrid disciplines, creating a more holistic community based process to improve overall review outcomes.

#### 2. A HISTORICAL SNAPSHOT

The first international congress on Peer Review in Biomedical Publications encouraged a systematic examination of journals [9]. The congress highlighted issues across a wide spectrum of experiences, disciplines and journal and that whilst there was general agreement of peer review not be abolished, there are still questions regarding validity and usefulness [19]. Over time the emperical approach to peer review has led critics to discribe the whole system as generally allowing conventional work to succed whilst discouraging innovative thinking [9]. There are many differing aspects to the social life of the peer review process. To expanding on the concept of the social life of peer review, Knoll [9] discusses the study of peer review as ... "a social process, not a technical one; that it differs from time to time and place to place; and that so far no precise emperical means exists to choose 'the best' method of peer review".

The lack of faith regarding the peer review process has not prevented the adoption of the process becoming a metric which academic scientists need to adhere to in order to maintain and build careers, ensuring grant funding. The groups of scientists that are working to produce papers and are also involved with the peer review process are in some ways working on a couple of different levels (at least).

#### 3. PEER REVIEW PROCESSES VIEWED AS SOCIAL KNOWLEDGE NETWORKS

In more recent times "peer review has become a powerful social system" [9] which has multiple layers of knowledge networks linking and supporting its members within these communities of practice. There are the established groups which maintain long standing networks, and in relatively recent times, are emerging as much more formal and systematic, which points to a more impersonal process over all [9]. Peer review is not by any means a linar process, and like any community which is active and dynamic involves complex social exchanges.

There are many differing types of contraints, both positive and negative which have impacted the emerging development of the current peer review process. The social complex adaptive activities of the peer review can not be dismissed, as journal editors themselves discribe the path of the peer review as "as ineffable and subjective, human process... which should be a civil discourse between colleagues", but this can be at odds with the reviewers themselves [9] [7] [2] [8]. This highlights the difficulties involved with assuming that the approach to peer review has clear "definitions" to adhere to.

The perceptions of traditional forms vs non-traditional forms varies between disciplines and groups of scholars, for example, standard publication are generally viewed as refereed journals, books and monographs, whereas, online publications are viewed as new forms of publication which have not been as rigourously peer reviewed, if at all [8]. More senior scholars were less likely to use newer forms of publication outlets [8]. Through their research, King, Harley [8] highlighted points made by interviewees that "dispite the hesitance expressed about online (only) publications, many aspect of online communication and publishing appealed to several of the interviewees:

"The newer ways of doing it are the kinds that I'm really interested in... I like the dynamism of the digital publication. So, for instance, publishing a paper as a PDF, and then distributing it through a website to me is a really interesting way of doing it".

The various layers of peer review include perceptions of all those involved. Increasingly the current "usage" of peer review by scholars (and even more so by institutions) is one of "endorsement" or measurement for promotion and grant funding. Editors however, site a more communal approach, while some reviewers can engage the process from the point of view of validation. Adding layers to peer review process are particular various editorial, house styles and procedures of the journals themselves, and the communities that sustain these activities. Journals are organizations with their specific disciplines, and are in effect, complex systems with networks to wider connections to the academic and publishing community. However, this community is not a single entity, rather it is a collection of networks interacting within multiple communities that is constantly evolving [9] [15].

These communities are dynamic and simultaneously engage in a multitude of functions and operations that have developed specific characteristics. Knowledge transfers for individual communities are particularly organizational specific within highly operational or project orientated environments [11] [12] [4] [6]. With regards to the sustainability of communities, general methodologies developed for supporting organizational communities could be applied to the peer review community, and the following key concerns should be considered:

- Dynamic methodologies are needed that consider the nature of the interactions within their disciplines as complex organizational systems.
- Such methodologies need a holistic approach; reductionism as an approach will not work with complex systems.
- Scalability is a fundamental aspect of holistic methodology in understanding different levels within a system such as the scope and vulnerabilities.
- Integration of human based systems and the physical organizational operational processes and their networks are crucial as a basis for a holistic methodology.
- The areas of expertise required as part of a holistic methodology would be the combination of socio-technical systems thinking (bringing together practice, physical structure, purposes and constraints, people, processes, infrastructure).
- The following are the areas of expertise which are needed in order to attempt a holistic methodological approach specifically designed with communities in mind;
  - Knowledge networking that focuses on the practical implementation aspects.
  - Knowledge network systems to support the formulation of community development strategies.

HIGHER LEVEL SYSTEM / ORGANIZATION / ENVIRONMENT

SUBSYSTEMS / COMPONENTS / PEOPLE

Figure 1. Emergence of an autopoietic community of practice places Nousala's [14]. spiral knowledge exchange model in the systems complex hierarchy of an autopoietic organization. Dvnamic activities of entities at the focal level within the triad are enabled by laws governing interactions of subsystems and constrained by conditions imposed by the supersystem [20] [4].

#### 4. COMMUNITY KNOWLEDGE NETWORK PRODUCTION

Scholarly societies reflect much of the behaviour of communities of practice (these being established communities, as opposed to communities of interest (CoI) which are still in formation).

Harley [24] discusses journal publishing programs that, "frame the development and scope of knowledge in the field. The peerreview process establishes and develops fields by creating peers that can work together to advance new knowledge or the application of new techniques ...[1]. Many journals, particularly those run by scholarly societies, serve to circulate reviews of research, conference information, bibliographies, and other information in the field".



Fig. 2. A social network created by a "human attractor" within the organization. "Faces" in these figures correspond to people/actors belonging to the organization at the level of subsystems/components (see Figs 2 & 3). **a**. A "human attractor" seeking knowledge to address a high-level organizational imperative or need. **b**. Other seekers socially transferring knowledge relating to what the "human attractor" seeks to know for the benefit of the organization. **c**. Other actors in the organization who are not connected to the seeker's current interest. **d**. A knowledge transfer between individual actors. Line weights indicate strength of the connection. The open vertical arrows indicate the possibility that the community may assemble and generate knowledge that will be valuable in addressing organizational needs [15] [6].



#### SUBSYSTEMS / COMPONENTS

Fig. 3. The coalescence of a community of interest (CoI) around a "human attractor". The human attractor seeks knowledge to solve organizational needs addressing high level imperatives and goals. Bright smiley faces represent people/actors receiving organizational/social rewards for their involvement in addressing the organizational need. Such rewards reinforce the individuals' involvement in addressing the corporate need. Open vertical arrows indicate the value/importance of the assembled, ordered and directed knowledge in addressing higher level organizational requirements. The light dotted line surrounding the attractor's network indicates that participants and others begin to see the

network as a specialized community addressing particular needs [15][6].

In the case of the scholarly society, the human attractor is generally the key editorial individuals that are "attracting" others to interact in relation to the needs of the members and that of the society (as explained in figure 3, the bright smiley faces representing organizational social rewards). In figure 3 the light dotted line that surrounds the attractor's network would be reviewers and authors that are participating and others that are wanting to interact with the community's specialization and particular needs.



Fig. 4. Stabilization around a human attractor. Emergence of processes within a stabilized community of interest. Dashed arrows represent control processes. Solid arrows represent knowledge production processes. Knowledge about how to form and sustain the community is still emerging. **a**. Community facilitator. **b**. Emerging boundary between the system by those who identify themselves as participants in the community (for the purposes of the community only) and others in the community. **c**. Faces crossing the boundary are people in the process of being recruited and inducted into the community [15][6].

Nousala and Hall [15] discuss the coalescence of the community continuing as is the situation illustrated in Fig. 4. arising with the development of specific tacit procedures and routines necessary for sustainable development and maintenance within the community. Specific tacit procedures and routines represent tacit structural knowledge "at the level of the community as an entity in its own right [10]". "It is at this point where the borderline of autopoiesis is reached [6] [15]".

A key factor (amongst others) for the transition from community of interest (CoP) to a community of practice (CoP) is "if individuals receive personal and social rewards they value as a consequence of belonging to the community they may take active roles in maintaining community goals and aspirations, This diminishes the need for a particular personal attractor to coordinate organizational survival and growth. Thus, the community becomes more autonomous [6][15]".

#### 5. SCHOLARLY SOCIETIES AS COMMUNITIES OF PRACTICE

Societies have traditionally been key to the peer review process for its members. They have been well placed to maintain, develop and operate resource platforms for their members. Scholarly societies like all knowledge-based communities are highly complex systems that evolve and mature through the phased emergence of new features and capabilities. Development and support of successfully sustainable communities needs to be based on a better understanding of how these features and capabilities emerge. To comprehend the impact of emergent behavior within and beyond communities requires an understanding of the social or sociological aspects of a system in relation to the explicit formal/physical structures in the communal entity. The following figure 5, is a visual representation of the social or sociological aspects of a system in relation to the explicit formal/physical structures in the communal entity displaying knowledge based activities of scholarly societies.



Fig. 5. Semiotic autopoiesis. State where the practices to form and maintain the community have been objectified and documented (as indicated by the records icons). Grey faces – those following codified knowledge (**a**.) about how to manage internal and external monitoring processes providing overall feedback control. White faces – those following codified knowledge (**b**.) about the production process. Black faces – those following codified knowledge (**c**.) about the product quality control cycle. **d**. codified knowledge about induction process recruiting new individuals into the community to satisfy new needs and to replace attrition. **e**. codified knowledge about environmental monitoring processes. **f**. codified knowledge about the vote stablish and sustain the community itself [15][6].

Human organizations like scholarly societies, are hierarchical complex adaptive systems. Within these systems knowledge exists at many different levels in tacit or objective forms. This knowledge is necessary for the survival of the organizational system. Individual and organizational knowledge is held in a variety of forms. These different forms of knowledge range from tacit organizational routines belonging to internal communities [10] to physical layout of plant and offices [10] and corporate documentation [5][13][16].

The theory, which informs the discussion regarding communities of practice, is in part based on the Popper's three world model [18][17]. The exchange between tacit and explicit and the individual (or community) and their larger knowledge networks occurs between "World 2 and World 3" as shown in figure 1.



Figure 6. Modification of Popper's three worlds diagram to show cyclical movements, The circle emphasizes cyclic exchanges between world 2 and world 3 as world 2 attempts to represent and interact with world 1 [14]

Harley [24] discusses scholarly societies as having "traditionally been major players in the publication and peerreview process". Societies are key to managing, editing, maintaining, developing and operating resource platforms for their membership. Harley [24] argues that "societies are thus well-positioned to managing several editorial and peer review functions. Harley [24] lists the following as possible functions that scholarly societies could provide, including:

"The creation of *overlay journals*, minimalist journals that provide peer review but not a publishing platform [22]. Still fairly speculative at present, an overlay journal would mine self-archived "raw" author manuscripts from repositories and carry out publishing functions such as peer review management, editing, and perhaps branding [23]. The actual published content would continue to reside in the repository, perhaps with an updated postprint reflecting any revisions and updated metadata reflecting the journal/society brand that carried out the peer review. The overlay journal would then link to the content via a Table of Contents.

The creation of other outlets to aggregate and filter published content. For example, virtual journals published by the Joint Institute for Nuclear Astrophysics aggregate articles from other publication outlets for easy consumption [3]. Likewise, societyspecific RSS feed aggregators could bring various types of publications together for scholars (similar to functions provided by H-Net listservs in some humanities and social sciences)"

Scholarly societies face obstacles from dependency on revenue to carry out a range of activities, including publishing. Other obstacles include scholars working in interdisciplinary and emerging areas may find it difficult to align themselves to a single society [24].

Organizational sustainability requires positive and negative constraints within the dynamic structure of the organization to support the emergence and sustenance of learning cycles. "Organizational learning cycles" [6] [10] begin with and involve coordinating the learning cycles of the organization's individual members, who then share, combine and extend personal knowledge to build organizational knowledge.

#### 6. CONCLUSION

For organizations to maintain themselves against entropy, change and competition, they must assemble, deploy, preserve and replicate knowledge to respond. Knowledge in the organizational context is any kind of information that has survival value [11][13][15][6][4][16].

Without the foundation of sustainable practice and processes, the build up of the internal knowledge networks will not occur. Instead, there will only be information systems and management, which do not function in the same way and can not take the place of tacit knowledge networks [11][12][16][25][6] [13].

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# Peer Reviewing as a Quality Assurance Methodology for Scientific/Engineering Publishing

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# ABSTRACT

A quality assurance (QA) methodology may support a professional approach for conducting an objective review process of scientific manuscripts to be considered for publication in a scientific journal. In this paper we present the benefits of using QA for Peer Reviewing and we compare the relevancy of the specific criteria and methods of the QA to our fields of research in Engineering and in Mathematics.

At last we prove that Peer-Reviewing perhaps may be improved but it certainly can not be Peer-Reviewed.

**Keywords:** Peer Reviewing, Quality Assurance, Mathematics, Transmitter, EE, EHF, industry.

# **1. INTRODUCTION**

A quality assurance (QA) framework defines guidelines such that a group of reviewers will judge the manuscript accordingly and the recommendations to the editor will be uniform.

These guidelines should define the paper's specifications such as setting a product's specifications as related to the contents and the structure and building blocks. It should define the structure and contents of the paper's title, abstract, introduction, methods and materials, results, discussion and summary and conclusions.

A scientific review process usually involves few reviewers. The editor must ensure that the review process will be handled uniformly and consistently by all the reviewers. This may be accomplished only with strict definition and guidelines to the reviewer who judges the manuscript. QA methodology supports uniformity and consistency. It supports the editor's decision such that a wide variability among reviewers recommendations can not occur. QA methodology eliminates a decision which is based only on an individual own experience and support the review process by guiding it to a clear and understandable scale.

A reviewing process must always follow the same dictated guidelines. Nevertheless, in each area of research, higher priority should be given to different criteria, according to their relevancy in the area. For example, the reviewers of a mathematical article must be carefully selected from the group of experts in the specific relevant area of research. This ensures that all the claims in the article are checked correctly and the article is free of mistakes. Moreover, it is very important to have a peer reviewing in Mathematical articles, in order to understand thoroughly not only the proofs, but also the applications, if there are any. High quality peer reviewing in Mathematics also distinguishes between articles that contain new developments in the relevant areas or even breakthroughs, and articles that do not have any new material and have no scientific importance.

On the other hand, the Electrical Engineering, EE, contains a wide area of disciplines from physical fields of solid states, optics, electromagnetism to systems such as communications, signal processing, control, software and much more. The common criteria of evaluation of EE papers, besides innovation and correctness, are the practical importance, up today relevance to applications, and the ability to show results. This approach is different from mathematics where the analytical derivation is a must and practical value is a bonus.

The Peer Reviewing method is not the only possible Quality Assurance methodology for evaluating data and knowledge, as there exist some other Q.A. methodologies in other fields of knowledge. For example, Financial Reports are the products that are being quality assured in Accounting. The methodology being used for this purpose is called Auditing [Yaniv Wolf, Price Less Finance Solutions Ltd., ISRAEL]. Therefore scientists sometimes wonder whether Peer Reviewing is the perfect methodology for quality assuring papers, i.e. it is desired to know can the Peer Reviewing process be improved, or even brought to perfection. In this paper we prove that the process of improving the Peer Reviewing methodology is limited.

The following paragraphs are presented as follows: Chapter 2 presents the QA methodology and its significance in Peer Reviewing in particular. Chapter 3 deals with Mathematical articles, emphasizing the most important criteria for Computer Science and for Applied Mathematics. Chapter 4 gives a survey of the relevancy of the QA methods to industry trends in Electrical Engineering. Chapter 5 proves that Peer Reviewing cannot be peer reviewed, and finally, Chapter 6 presents our conclusions from the discussion.

# 2. THE Q.A. METHODOLOGY AND ITS SIGNIFICANCE IN PEER REVIEWING

A quality assurance (QA) methodology may support a professional approach for conducting an objective review process of scientific manuscripts to be considered for publication in a scientific journal. The European Patent Office (EPO), has developed a QA procedure to maintain a reliable and accurate data base of patents [1].

Hammers and Schmitt [3], discuss the Quality Gate approach as a QA methodology to ensure that in the process of product development customer requirements would be achieved.

A QA framework defines guidelines such that a group of reviewers will judge the manuscript accordingly and the recommendations to the editor will be uniform and consistent.

These guidelines should define the paper's specifications such as defining a product's specifications as related to the contents and the structure and building blocks. It should define the structure and contents of the paper's title, abstract, introduction, methods and materials, results, discussion and summary and conclusions.

A scientific review process usually involves few reviewers. The editor must ensure that the review process will be handled uniformly and consistently by all the reviewers. This may be accomplished only with strict definition and guidelines to the reviewer who judges the manuscript. QA methodology supports uniformity and consistency. It supports the editor's decision such that a wide variability among reviewers' recommendations can not occur. QA methodology eliminates a decision which is based only on an individual own experience and supports the review process by directing it to a clear and understandable scale. In an editorial, Greifender [2], discusses the issue of young professionals who wish to publish in peerreviewed journals. He states that publishing in peerreviewed journals appear to be a barrier, because in the eyes of young professionals these journals seem to be a place for only established researchers. But this is not true, or should not be. Peer-review is a way to sort good articles from bad, and not old from young.

Research regarding biomedical publication in general has raised several areas of concern regarding publication ethics [5]. Comparing results of industrysupported systemic reviews of medications with Cochran reviews showed that industry-supported reviews generally had uniformly positive recommendations for the experimental drug. Thus the editorial process, must be defined and monitored carefully.

It is assumed that writing a scientific paper has the analogy of product design. There are specific requirements that a product should comply with. The design outcome, the product's specifications are a direct derivative of the requirements. Therefore, once product specifications are given we may state that a scientific paper peer review process is completely analog to conduct any audit either for a tangible product or a no tangible process.

In an editorial, Lee and Greenley [4], highlight the QA methodology the editorial process follow to ensure that only quality papers will be accepted. They state that the editor in charge of any manuscript almost definitely has a strategy for its review. A good review is constructively critical, but provides detailed advice on how the content and presentation can be enhanced.

Following are basic assumptions supporting as an anchor the review process: a. the manuscript is the product under audit; b. there is predefined specifications of a generic product containing a set of characteristics it should comply with; c. paper characteristics: editing/writing style, manuscript generic content: title, abstract, introduction, methods and materials, results, discussion, summary, conclusions and recommendations, references; d. there is a predefined audit procedure to follow including two main categories: predefined issues/points to be answered yes/no (e.g.: the title is clear, the abstract brings clearly the subject explored etc.) and open questions for the reviewer's free feedback; e. there is a marking scale to follow: acceptance, minor revision, major revision, and rejection; and f. the reviewer is an expert in the specific professional discipline.

Given the above mentioned specifications, characteristics and guidelines, the review process could be performed by several reviewers in parallel to support the editor in his decision.

Some basic rules of thumb to follow: a. the manuscript should be read fluently with no stoppages (sentences should be clear cut and not clumsy); b. it should be integrated and supported by graphical illustrations that present the results and may explain the behavior of the results (e.g. trends); c. the abstract should bring in short the subject, the methods and the main results; d. the introduction has to bring the up to date relevant references published in the subject presented in the paper; e. the discussion must be creative and not just a repetition of the basic results; f. the summary has to point out whether the aims and objectives were achieved with elaborating the case that they were not achieved.

Once the editor receives the reviewers' recommendations, he should conduct a kind of an incoming inspection. This inspection should verify what are the markings assigned to the paper under review by the group of reviewers (should be more than two). In the case of a total consensus (same markings), the decision is significant. In the case of extreme markings (e.g. one reviewer recommends acceptance while another reviewer recommends rejection), it creates a dilemma and it is not a trivial decision. Here is the point to indicate that the more the review process is specified and strictly guided, given that the reviewer is an expert in the subject matter, it is very rarely that the latter situation (extreme recommendations) may occur.

## 3. PEER REVIEWING IN MATHEMATICS AND IN COMPUTER SCIENCE

Peer reviewing has as many variations as there are research areas and more. Even in different areas of Mathematics itself it has a variety of conceptual rules. For example, in the area of Applied Mathematics, most of the articles include some applications of the theory on top of the theory, or sometimes the articles include some numerical results, e.g. graphs or tables, while articles in Pure Mathematics consist mostly of abstract theories and pure mathematical proofs.

Mathematical articles have always been peer reviewed. The reviewers of a mathematical article are selected by experts in the relevant area of interest. That way, the claims of the article are carefully examined to avoid flaws. A mathematical article should never be accepted by peer reviewers if it has even a single fault in any of its proofs. Moreover, experts can find errors that can not be detected by non-expert reviewers even from the same area, and can also approve valid claims that might seem wrong to non-experts. Namely, valid articles are not rejected and articles that contain flaws are corrected. For example, in many mathematical articles, it is common to start a phrase with "It is easy to see...". In such cases experts are qualified to understand what stands behind these words and can determine their correctness.

Peer Reviewing is of great importance in all mathematical areas, since Mathematics is being used in all scientific areas, such as Physics, Chemistry, Computer Science, Engineering etc. If one minor flaw is neglected, wrong theories might be developed and cause immense disasters. The following examples clarify our assertions:

- Wrong mathematical calculations may result in defective products that may risk lives.

- It is common for computer programmers to check their programs by running them on several inputs. This is not a proof of the validity of the program since there might be an input that results in a wrong output. A good peer reviewing of programs must determine whether or not the program runs properly on every input. That is not an easy task since it was proved [8], [9] that there exists no algorithm that can check the validity of a program, and therefore it can be checked only by expert people.

- In Applied Mathematics as in Computer Science, values are asymptotically approximated in terms of "Big O". In such calculations even a small mistake can cause the big O approximation to fail.

Moreover, it is very important to have a peer reviewing in Mathematical articles, in order to understand thoroughly not only the proofs, but also the applications, if there are any. High quality peer reviewing in Mathematics also distinguishes between articles that contain new developments in the relevant areas or even breakthroughs, and articles that do not have any new material and have no scientific importance.

Our conclusions can be termed into the following equation:



Notice that we may substitute the first term of the equation by the result of this equation. In such a way we define an iterative process that constantly improves the quality of the article.

# 4. PEER REVIEWING IN ELECTRICAL ENGINEERING

Electrical engineering (EE) is a field of engineering that generally deals with the study and application of electricity, electronics and electromagnetism. The EE contains a wide area of disciplines from physical fields of solid states, integrated circuits, optics, electromagnetism, electrical power generation and transmission to systems such as telecommunications, signal processing, computers, control systems, software and much more.

The common criteria of evaluation of EE papers, besides innovation and correctness, are the practical importance, up today relevance to applications, and the ability to show results by numerical analytical calculations, simulations, and experiments. This approach is different from mathematics where the analytical derivation is a must and practical value is a bonus.

The relevance to industry trends can be illustrated by few examples. The analog signal processing, that was a developed area in the 70s, is almost obsolete now and the research is very much reduced. This includes methods such as Surface Acoustic Waves and analog computing. In order to publish research in these areas the reviewer has to be convinced that there is a reason to perform such a research and that is interest in the results. Among the areas that became popular, we can mention the frequency band Extremely High Frequencies (EHF) from 30 to 300 MHz. Many research areas related to EHF are of interest either related to propagation or communication coding and modulation schemes or many others. There is no need to convince the reviewer on research relevance. Exceptions may be found in topics that are premature at the time of initial publication and have to wait to the time when the implementation methods such as large Integrated Devices are ripe to handle the required complexity. For example, the Low Density Parity Codes (LDPC) invented by Gallager in the 60s [6], waited more ten 30 years for Neal and McKay rediscovery [7] since then raised interest and to become an industry standard.

The performance achieved is a criterion of evaluation. The results that are present in EE papers are obtained by a variety of methods: methods without implementations such as numerical calculation of analytical formulas, and numerical Monte Carlo simulations, and methods that require implementation, such as lab experiments and field tests. Of course there are exceptional areas, such as Information Theory, where the analytical bounds are the common results. The reviewers are expecting improvements achieved. For example in telecommunication we expect increase in capacity or saving in bandwidth and power required.

#### 5. PEER-REVIEWING CAN NOT BE PEER-REVIEWED

Some doubts have been presented lately about the efficiency of Peer Reviewing, and the question "Can Peer-Reviewing be Peer-Reviewed ?" has been often presented . The answer to this question is: "Certainly Not!". It is not because the Peer-Reviewing method is perfect. The reason is much simple – The Peer-Reviewing method can not be Peer-Reviewed. We prove that claim using The Diagonalization Method of George Cantor, that was published in 1873 [8].

As we mentioned before, Peer Reviewing is a Quality Assurance method, and if Peer-Reviewing is being Peer-Reviewed, then there exists an Q.A. that can examine properly A.Q. methods. We thereby prove the following claim:

*Claim* There is no Assurance Quality method that can examine properly Assurance Quality methods.

**Proof** Assume on the contrary that there exists an Q.A. method named PERFECT, that can examine properly Q.A. methods. Namely, for every input that consists of a Q.A. A and a Product P, PERFECT can correctly report whether or not A evaluates P properly (see figure 5.1).

Figure 5.1: PERFECT



Notice that we may regard the Q.A. methods as products. For instance, the products that the Quality Assurance PERFECT examines are Quality Assurances. Therefore, we may let a Q.A. examine itself, and hence we define the following Q.A. DUMMY, that examines the evaluation of Quality Assurances over themselves. The Q.A. DUMMY unsuccessfully tries to imitate PERFECT: It receives a Q.A., denoted by A, as its input, and examines whether or not the Q.A. A evaluates the Product A properly. For that purpose DUMMY uses

the evaluation of PERFECT for the Q.A. A over the product A , and returns the opposite answer (see figure 5.2).





Since DUMMY is a Q.A. and it is also a product, then DUMMY can evaluate its function. But does DUMMY report that the Q.A. DUMMY evaluates The Product DUMMY well?

The answer can be demonstrated in the following Structure 5.3:



The terms "accept" and "reject" of Figure 5.3 means that the Q.A. in hand answers "yes" or "no" respectively, and the term [A on P] means that the Q.A. A receives and evaluates the product P. Using this terminology, we would like to find out whether or not the Q.A. DUMMY accepts the Q.A. DUMMY.

If DUMMY accepts the input DUMMY, then PERFECT rejects the input [DUMMY on DUMMY]. It means that PERFECT reports that when DUMMY examines the input Q.A. DUMMY, it rejects it. Since PERFECT always reports correctly, then DUMMY rejects DUMMY.

On the other hand, if DUMMY rejects the input DUMMY, then PERFECT accepts the input [DUMMY on DUMMY]. It means that PERFECT reports that when DUMMY examines the input Q.A. DUMMY, it accepts it. Again, since PERFECT always reports correctly, then DUMMY accepts DUMMY. Contradiction.

The contradiction of the above proof shows that no such Quality Assurance as PERFECT exists, and thus no Quality Assurance method can examine the functionality of other Quality Assurance methods. Therefore Peer-Reviewing can not be Peer-Reviewed.

#### 6. CONCLUSIONS

Although there does not exist a perfect or even one uniform process for evaluating scientific papers in all areas of knowledge, the Peer Reviewing methodology seems to be a good professional procedure for assuring the quality of papers that should be included in scientific journals.

QA methodology should be adopted to all areas of science, while emphasizing the most relevant criteria in each area. This will support uniformity and consistency of the various peer reviewers of the papers. It will also support the editor's decision and will not allow a wide variability among reviewers' recommendations to occur. QA methodology application will eliminate the editor's decision to be based only on an individual own experience and will support the review process by bringing the reviewers to a clear decision.

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# "DOUBLE(D) STANDARDS"

Neutral formalism and inspiring forward; challenging the ontological space of peer review perhaps

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## ABSTRACT

Usually when I am asked to review a traditional scientific article or work, I look for theoretical and methodological quality, readability, formalities and finally; I propose improvements if needed. This is a traditional way of peer reviewing, neutral formalism and according to established standards. It is a local genre reviewing what is there and thought suitable for traditional scientific works.

Peer reviewing postmodern scientific works I use other standards or "standards" only. Rather, I ask questions. I wonder if it is possible to share, mix or blend? I wonder if it possible to think both and – local <u>and</u> global perhaps genres? I wonder if it is possible to create a new language and a new thinking and inspire forward? Interrogating again and again the ways in which research is done and what values inform desirable research.

**Keywords:** Peer Review, Subjectivity, Philosophy of Science, Quality evaluation and assessment, Tradition and change.

#### INTRODUCTION

"The Paradox is the objective Undecideability, which is the Expression of the Passion of Heartiness, which in turn is the Truth. This way is the way of Socrates. The eternal, essential Truth: that, which is related essentially to an Existence essentially concerned with existing (all other knowledge is according to Socrates accidental; its Degree and Dimensions indifferent), is the Paradox. However, the eternal essential Truth is in no way the Paradox, but is so by its relation to an Existence. The Socratic ignorance is Expressing the objective Undecideability, the Heartiness of the one Existing is the Truth "(Kierkegaard;1994:140 my translation). Traditional research and subsequently traditional peer review builds on the scientific community's own creative recreation, and takes place calmly and under the protection by a superior meta narrative. There is thus some degree of consensus of standards and methods.

In postmodern and also poststructuralist writing the scientific (re)creation, on the other hand, is embodied in multiple paradigms and research networks, which have to sustain themselves and fight for their own existence without a superior epistemological or political narrative.

The difference between the two is not normative, but connected to placing the research in a more or less legitimized plurality.

If scientific plurality is secured by a meta –narrative the scientific production and subsequent evaluation will be conducted in singular terms. On the other side, if diverse, porous and plural research environments must legitimize themselves in constant dynamic processes, everything must be expressed in some kind of dynamic plurality. Lyotard explains: *"The classical dividing lines between the various fields of science are thus called into questions- disciplines disappear, overlapping occur at the borders between science, and from these new territories are born. The speculative hierarchy of learning gives way to an immanent and, as it were, "flat" network of areas of inquiry, the respective frontiers of which are in constant flux"/1989:39).* 

Reviewing traditional scientific articles or works, I therefore look for theoretical and methodological quality, readability (structure and language), formalities and finally, I propose improvements if needed. This is a traditional way of peer reviewing, neutral formalism and according to established standards. It is a local genre reviewing what is there and thought suitable for traditional scientific works. Science however, is in my view not just a particular methodology and an organized collectivity but also the staging of an intellectual drama. A drama in tensions between tradition and its non existence, and on the other side the author's own experiences of simultaneous justice and injustices between the "slow" action, the wild thinking and the sensible utterance. This is the case in traditional work but obvious in postmodern/poststructural work. In my view this is also the strengths of such works. Complexity, nuances, ambivalence, reflexivity and thus paradox openly displayed. Knowledge is seen as preliminary. Insecurity is normalized. The subject position is lifted without however leaving us to subjectivity only: Representing ultimately the possibilities for both a humanisation and democratization of science. The medium of judgment, again in my view, is therefore not - or cannot be just neutral formalism. It is the human preoccupation with truth.

#### NEUTRAL FORMALISM AND INSPIRING FORWARD

I think it is urgent therefore to explore alternative ways of peer reviewing. Of cause the traditional way is a great help and there is nothing wrong about being formal. On the contrary; it is important. What I fear however is instrumentalism and reductionism and that I fail to see and acknowledge important new research and new voices ultimately new thinking and new language. Fail forwarding innovation. The criteria that I use thus working opposite from what I think they do, working opposite from what I want. And to be realistic about it: We are in difficult but decisive power - knowledge relationships making it important to know or recognize not only what power and knowledge is or might be but also what it might do. Ultimately this is therefore a discussion about the inclusion/exclusion relationship in science.

Peer reviewing postmodern and/or poststructural scientific works I use other standards or "standards" only. I ask questions both about what is there but also about more. I try to inspire forward and include perhaps more global genres.

The use of quotation marks is referring to a double b(l)ind or knowledge that loses itself in the necessary blind spots of understanding, and thus what Paul de Man, using Derrida, termed *"blindness and insight"*, where the necessary exclusion is the very organizer of whatever insight might be made and critical texts always turn back on the very things they denounce/renounce (de Man, 1983 in Lather 2004:1). A simultaneous process of both affirmation and negation, forgetting and remembering, tradition and change, knowing and not knowing or a *"process which demands both a keeping in mind and letting* go" (Krell, 2000:1). A simultaneous process which Derrida through his work has described as an opening up of possibilities through "Responsibility and Hospitality towards the Other to Come (à - venir) and through a double(d) logic of the Gift". The "Come" is evoking the sense that "everything remains open and still to be thought" (Derrida, 1983 in Royle, 2003: 44), securing open and dynamic processes always. The "Giff" is referring to possible bindings in the giving getting relationship reminding us to question them always, ultimately being engaged in power/empowerment issues. A best case scenario being blindness thereof the double b(1)ind. As we shall see this invites to discussions about authority and subsequent autonomy issues. I will return to this, but obviously, due to space limitations, just in a very superficial way. It is always however, in the background whenever subjectivity is discussed.

The first "standard" that I use or question that I ask is the following; does the writing contribute in a substantive way to our understanding of social life? Does the writer demonstrate a deeply grounded (if embedded) social scientific perspective? Does this piece seem "true" – a credible account of a cultural, social, individual or communal sense of the "real"?

Second, does the text open up and invite interpretive responses? Does it succeed aesthetically? Is the text artistically shaped, satisfying, complex and not boring?

Third, is there adequate self-awareness and self exposure for the reader to make judgement about the point of view? Or rather how has the author's subjectivity been both a producer and a product of this text?

And fourth, does the text affect you emotionally or intellectually? Does it generate new questions or move you to write? Does it move you to try something new or act? (Richardson and St.Pierre 2005: 964)

I also use a fifth "standard" even if I clearly see that it is an extension of the other four: Can the text be read as a reversal and thus as an exemplary reading of the politics of the example? Does it allow the possibility of beginning not with a politics of which we would then give examples, but with examples out of which we might invent a politics?

And last but daring: Does the work allow reflections on the different methods whether quantitative, qualitative, modern or post modern in a view not to reject or disqualify any other rather to get wiser concerning both what the different types of methods can and cannot say, do and cannot do?

I wonder if it is possible to share, mix or blend traditional peer review with these questions? I wonder if it possible to think both and – local and global genres? I wonder if it possible through this to create a new language and a new thinking and inspire forward? Interrogating again and again the ways in which research is done and what

values inform desirable research: Developing a questioning knowing in both research and subsequent peer review.

Ultimately this is about making ontological politics concerning both research and peer review possible. It is about risk taking and responsibility hopefully creating space, getting space and giving space. My answer to the question about sharing, mixing or blending is yes, but before we go there, I want to comment a little bit more on subjectivity.

# THE SUBJECTIVE TRUTH, HEARTINESS; THE TRUTH IS SUBJECTIVITY

All judgment is subjective or contains some elements of subjectivity. We cannot therefore question subjectivity in itself. On the contrary we need to stay in it or with it and recognize that it is always there. The important question is therefore not whether judgment is subjective or not, but whether good consequences follow. It requires that one is honest about oneself and no fear of the personal or being personal; an honesty about being a subject in other words.

Initially this might be felt as a weakening of our review efforts because we are so used to thinking that 1) Objectivity is possible. 2) Objectivity is neutral. 3) Objectivity is just. 4) Objectivity is knowledge based. 5) Objectivity is good. And it is of cause all this, but through me and my subjectivity, my voice, my style always and not opposed to knowledge.

On the contrary, listen to this: "It is indeed a question of <u>knowledge</u> again, but first of all of knowing how, <u>without</u> renouncing the classical norms of objectivity and <u>responsibility</u>, without threatening the critical ideal of <u>science and philosophy</u>, and therefore without <u>renouncing knowledge</u>, one can still pursue this demand for responsibility" (Derrida, 2002:66, underlining replacing italics in the original). Increased emphasis on the self or the personal does not therefore compromise knowledge or contents, but leads us to confront difficult questions, and encourage a process of showing the contents' relevance in/for research (read society, people, praxis ...) and ask further and more.

The six "standards" or questions above in my view a way of knowing how or at least a suggestion as to get to know "something": A way for reviewers therefore of keeping the object of research through or following the concept through. Not thinking truth will ever be found, but truthful processes. In the long run therefore this is a process of turning weakness into strength and no threat to ideals.

## CHALLENGING THE ONTOLOGICAL SPACE OF PEER REVIEW AND INSPIRING FORWARD

Then we are back to the issue of challenging the ontological space (of Being) of peer review and my clear yes both to mixing and blending and possible effects. The "ontological space" is referring to the gathering together in order to make space for the existence of an activity or thing. The way I see this then is that the "double(d) standards" is making it possible to envisage the ground for a re-thinking and re-conceptualization of peer review. Not what it is once and for all, but opening up for more and other perspectives and conceptions, turning peer review into conversation creating space giving space getting space.

I cannot therefore see why we cannot mix or why these "standards" cannot be used for reviewing traditional research. On the contrary it might, as suggested above, strengthen both research and the review process. It might however, and this is also in my view a strengthening, lead us to more humble positions reducing perhaps, if there is such a thing, the belief that our research can speak to everybody always. In the long run this might therefore also challenge a traditional notion of expertise. And again; authority issues might emerge. In conversations however these are issues that are ultimately pushing and pulling us forward.

Through other modes of knowledge perhaps; disciplinary (constructed in the university) and trans-disciplinary (found outside the university), technical (intervening in practice in an objective manner), dispositional (individual competence to reflect upon action) and critical (knowledge undermining the practice setting) ... (Scott et al. 2004 in Dobson, 2010): Privileging both process and product, circular and linear writing. Securing dynamics in other words.

"Double(d) standards" therefore to open up perspectives and ultimately make science interesting for more and other people. Including more perspectives, other perspectives and other people' perspectives - thoughts not yet thought.... "Double(d) standards" to open up for more and other voices. "Double(d) standards" to breathe life into research to make it relevant for peoples' lives. Expanding the genres of what counts as knowledge, both in terms of how it is acquired and how it is to be judged as valid and reliable. Tradition <u>and</u> change: Formalism <u>and</u> more

#### "CONCLUSION"

This is not about reducing quality neither in science nor in peer review. However what this might be about is reducing or lowering some linguistic thresholds in both. Reminding us further that we in critical ways always should reflect over things we might take for granted, and the conditions that are inscribed in different ideas, structures and forms of our practices.

Ultimately this is built on an understanding that quality discourses differ from traditional development discourses, and a notion that the most interesting issues we might not be able to judge at all - just break. Break in order to move on, try more, and try harder.

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Proceedings of The 14th World Multi-Conference on Systemics, Cybernetics and Informatics (WMSCI 2010)

# Peer Review – A Personal Point of View<sup>1</sup>

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<sup>1</sup> The publication of this paper does not indicate endorsement by the Institute for Defense Analyses, nor should the contents be construed as reflecting the official position of this organizations.

### ABSTRACT

Peer review is often seen as an onerous part of the publishing process. In fact, in many cases it has been high jacked for reasons other than the original Blocking of publication, furthering purpose. political agendas, and padding resumes are all examples. A stringent code of ethics must be developed. Even then, it can be burdensome if not approached properly. Setting egos aside and using the process to your advantage makes it a desirable part of the publishing process, and can save an author's reputation in some instance. The material below covers the peer review, possible outcomes and what they can mean to the author. The views expressed are based upon personal experience from over 40 years in research.

**Keywords:** Peer Review, publishing, reputation, ethics, information sharing.

### What is Peer Review

Peer review is several things all related to publishing a piece of research. These things include:

- A concept Have a paper on research reviewed by a bunch of researchers not involved in the original research, but knowledgeable about the area.
- **A process** Find some reviewers that meet the above. Have each provide comments for the author and (maybe) a relevance evaluation.
- A set of Outputs Comments and relevance evaluation for a number of areas.

### How Peer Review is Used

Most uses of peer review today are not proper. Abuses abound. They include:

- **Product Improvement** very valid use, and relies on the comments of peer reviewers.
- **Product Enrichment** brought about by providing the author alternate points of view.
- Cross Fertilization of Disciplines providing the author suggestion for alternate

applications, or similar approaches in other disciplines.

- Consensus and Community Building achieved by grouping similar and contrasting papers on the same subject for open discussion and debate (recommendation by peer reviewers).
- **Protection of the "event"** An event may be a conference, symposium or workshop. Poor use where a worthy paper is not published to protect the event from controversy.
- **Protection of the "discipline"** Poor use where current discipline is used to exclude approaches and even topics.
- **Protection of the "publication**" *Poor use* where a worthy paper is not published to protect the publication from controversy.
- **Protection of the "science"** *Extremely* poor use where preponderance of opinion on conclusions would exclude an otherwise well formed paper from publication.
- **Exclusion of Ideas** *Extremely poor use* where approaches and conclusions are not evaluated on merit, but on alignment with current ideas.
- Exclusion of Membership Poor use where recommendation to publish is based upon the individual rather than the veracity of the work.
- **Publication Rejection** Mixed use. Some papers just need to be rejected. Most need to be provided guidance on how to bring the content up to standards of presentation.

Those in italics should be taught as unethical, and an ethical definition of peer reviewing is needed. Ethics is not provided in research curriculums, even though many such ethical frameworks exist<sup>2</sup> [1]-[10]. They may be provided in courses on philosophy, but that is not the same as tailored ethics for researchers. The ethics should be taught at the undergraduate and graduate level of research curriculums and be required for researchers. These ethics include when to publish (see below), misuse of the publishing process, the community service that is part of being a researcher in the field, including performing honest and unbiased peer reviewing, and standing up for improper uses of the peer review process.

<sup>&</sup>lt;sup>2</sup> References 8-10 present actual examples.

Publication of anything other than you have done a quality piece of research and cannot wait to share it with your colleagues is unethical. Padding your resume with publications is using the metric as a goal (the goal is good and significant research). You owe the community:

- Consider a colleagues input whether it is from peer review or not, as long as it is provided openly and honestly.
- Perform peer reviewing duties in your organization and your professional organizations. Limit review comments to those in which you have expertise.
- Be a spokesman for the poor use of publication numbers vice quality research on evaluations.

# Publishing

There are several reasons to publish.

- Your boss requires you to present a paper and it must go through peer review. Not a valid reason to publish, although the workplace environment may cause you ethical dilemmas.
- Your annual evaluation, or tenure review, will be judged partially on your ability to get published in your field. *The metric has been used instead of the real goal. The real goal for tenure or evaluation should be quality research.*
- You realize that **your resume requires some publishing content**. Again, the *metric has been used instead of the real goal. The real goal for a good resume should be quality research.*
- You have done a quality piece of research and cannot wait to share it with your colleagues. The only reason to publish.

# Where You Stand is Where You Sit

Peer review is legitimately used by a number of different classes of individuals. All of these have legitimate uses of peer review. Some of these classes include:

- Program Committee
- Conference Manager
- Journal Editor
- Publisher
- Grey beard in a research area
- Authors

Although, over the course of a career, I have been in most of these positions, I will adopt the viewpoint of the author in the rest of this work.

# **Publishing Your Research**

You have several choices, some opportunities require only an abstract, and will fit you into their agenda if the topic or your affiliation is appropriate. Others require a form of peer review, possible iterations, enforced formatting, and tight deadlines. The choices are yours and while the former is easier, the latter is much more useful to you and your career. What a pain you say, it might be rejected, or require extensive modifications. At the very least, it will require you to review and consider all comments even those from reviewers who did not understand in detail your area of research. Don't need that you say, well think again.

# **An Alternate Review Process**

If you worked for a major company like IBM or Microsoft, and you were preparing a proposal for a customer, you would have access to a team of editors lined up to make your work more comprehensive, get the grammar and spelling correct, and make sure that your message was on point and well presented. You would also have a team of experts that provide you input to the more subtle aspects of your work, and advise you on the related work and their outcomes, foundational work and its limitations, the math and its variations, related theory and subtleties of your theoretical work. Or, if you are proposing a piece of work, you get advise on whether similar approaches have succeeded elsewhere, feasibility of your approach, practicality of your approach and other subtleties. Most important, these experts will stop you from presenting a paper that doesn't reflect well on you or your organization, either from less than well thought out approaches, known blind alleys, or impractical implementation.

Don't work for IBM or Microsoft, only for a small university? Fear not peer review will provide these same services, and more, at no cost, without prejudice, and can make you look like a pro by providing the polish to your work that only a team of inter-disciplinarians can provide. Work for Microsoft or IBM? Peer review can provide you an independent opinion and comments that are free of marketing influence. What's not to like? A team of interested but independent individuals, all with credentials, will provide a critical review of you work without the biases apparent in your own organization.

# **Types of Peer Review**

Peer review comes in many flavors. The goal is to provide an unbiased review. Some will be done by strangers, professionals in the field, peers from your own organization, or other groups who may have some expertise in your research area.

- Open Reviews are conducted with full knowledge between the reviewer and the author (everybody knows each other by name).
- Blind Review One side or the other is shielded from identity. The author may be withheld from the reviewers, or the reviewers may be withheld from the author.
- Double Blind Review Both sides are not identified. In tight-knit communities, double-blind is not possible. Personalities, writing styles, references, even research topics can make anonymity impossible.
- Combination Some reviewers and authors are known others are not.
- Multi-Level Peer Review Can be any of the above, but requires the reviewer to be satisfied that the author has addressed the comments.

The most honest and least potential for bias would be double-blind, if anonymity can be maintained.

# **Peer Review Benefits**

An honest peer review can provide any or all of the following benefits:<sup>3</sup>

- Grammar, spelling and terminology
- Assumptions validity and alternatives
- Argument structures including logical,
- mathematical and fallaciousMissing information or argument steps
- Missing information or argument s
- Math checks

discipline

- Alignment with current work
- Citation of overlooked related works
  Stopping a paper that does not reflect well on the authors, the conference, or the

# **Peer Review Outcome Based Evaluation**

Peer review will determine whether or not your paper is presented and/or published, but the process provides far more than simple acceptance or rejection. Peer review has basically five outcomes, and several flavors of outcomes and each of them are not only good for you, but provide useful data that will improve you publication track:

- Outright Rejection Initially an ego deflator, but in the long run a reputation saver. Pay close attention to the comments. There is something not quite right about the math or the theory, or unbeknownst to you someone has been down this road before and written it up with either positive or negative results. Rework may or may not save the research, but publishing something with these flaws will diminish a reputation and tend to last forever, making repair difficult.
- **Conditional Rejection** Also an ego deflator in the short run, but the comments will be of several types and all can be reworked and resubmitted at another conference.
  - Not in line with conference or Journal themes – Could be as simple as more to get the appropriate audience. However, in multi-disciplinary conferences it may mean that you did not provide the necessary background and tutorial information for the broader audience. In the latter case, you may want to consider the steps outlined below under not enough detail.
  - Not enough detail In many cases this means the scope of the paper is too broad and detail was sacrificed in order to meet page limits. Consider revising with reduced scope or submitting with increased detail to a journal.
  - Not easily understood This may come about because the grammar, spelling and other administrative things are improper. Remember that just because you sent a draft doesn't mean that it does not need to be coherent, well organized and cover well the premises and conclusions. The multidisciplinary conferences will be big on this because the audience is varied, often multinational, and probably not familiar with the jargon of your research area. The cleaning up of jargon and grammar, plus following the formula of presentation will probably make the paper reach acceptance at the next conference.
  - **Rejection for reasons of Ranking** Usually couched with words that they received more good papers than they could

<sup>&</sup>lt;sup>3</sup> Reports published in major companies go through these checks.

fit into the conference agenda. This means the paper ranked too low, and without detailed comments you have to guess at the reasons for low rating. Comments, of course, will provide a roadmap. No comments mean that it doesn't quite match the theme or production quality of your competitors. Theme and production are covered above. Again, make the draft clean and as near to final as you can.

- Conditional Acceptance Actually a good outcome, because the reviewers are obligated to tell you the conditions for acceptance. Carefully read the comments and meet the conditions.
- Acceptance May or may not be a useful outcome. Either your paper or reputation is so good they want you to speak at their conference or your score was sufficiently high to reach the cutoff for the agenda. Just because you got acceptance, doesn't mean you didn't get comments. Carefully examine the comments and make changes as appropriate. If you didn't get comments back, the peer review has failed and you should immediately have a few colleagues re-examine you work for critical review before submitting your final copy.

#### Peer Review Outcome/ Benefits

When peer review can control the publishing outcome, the following table summarizes the benefits.

| Outcome  | Short Term<br>Benefit | Long Term<br>Benefit |
|--|-----------------------|----------------------|
| Outright Rejection                               | Х                     | ~                    |
| Conditional Rejection                            |                       | ~                    |
| Not in line with conference<br>or Journal themes | Х                     | ~                    |
| Not enough detail                                | Х                     | ~                    |
| Not easily understood                            | х                     | ✓                    |
| Rejection for reasons of<br>Ranking              | Х                     | ~                    |
| Conditional Acceptance                           | ~                     | ~                    |
| Acceptance                                       | ~                     | ✓ / X                |

There is always a long-term benefit and often a short-term benefit.

## A Choice or a Requirement?

Always prepare a thorough input for review process. It makes review easier and it provides more substantive comments. Sometimes a paper may take a couple of iterations through the peer review to get acceptance. These iterations are absolutely needed. Embrace the process and polish your work. Don't be discouraged. You have all of the reviewers working to make your work significant, well reported, and a lasting contribution to your area. After you have been published no one see the contributions made by the reviewers, only your brilliance<sup>4</sup>. Use this system well and your publishing track will be outstanding!

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- 9. Herbert J. Taylor, president, Rotary Club of Chicago, 1939-40 and Rotary International 1954-55. He lived from 1893 to 1978. During a business crisis in 1932, he wrote the "Four Way Test,". It was adopted as part of Rotary International in January of 1943., <u>http://www.rotaryfirst100.org/presidents/1954taylo</u> <u>r/taylor/index.htm</u>
- 10. The most remarkable of the Hammurabi records is his code of laws, the earliest-known example of an ethical code. Although these had the force of law in Hammurabi's domain. <u>http://www.fordham.edu/halsall/ancient/hamcode.h</u> <u>tml</u>

<sup>&</sup>lt;sup>4</sup> It would not be unethical to acknowledge a significant contribution made by a reviewer.

# On the New Scientific and Technological Methodologies on the basis of Philosophical Consideration

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## ABSTRACT

We have reported the process and concepts of structuring the Life support system taking account of the essential meaning of the ubiquitous system which has been treated on the insufficient discussion until now. This Life support system is synthesized from the Expanded EMR (Electric or Electronic Medical Record). And it has been structured on the basis of the essential concept of the ubiquitous system; that is, on such concept as the recovery of lost functions of ordinary persons it is synthesized, and there is the essential significance of the ubiquitous concept in this recovery concept of lost functions. The design concept of this Life support system has the embedding techniques of the communication system to be developed for the handicapped people as a module. As a result considering the transmission of information using the Life support system it has been

made clear that it is not sufficient to apply the ordinary Shannon's information theory to the handicapped situations, especially to the dementia situation which we define as a kind of handicapped situation. Therefore the information itself has been needed to be discussed from the fundamental point of view. Then we have presented and discussed three directions of consideration cases at same time in parallel. There the object of consideration is the information, but such a concept is needed to be applied for the fundamental concepts of modern science and technologies, especially with regard to the new information concepts the philosophical view points are needed to be applied for them, because their modern concepts are not sufficient on philosophical consideration and the fundamental human mind functions. In this paper we present the new methods to derive the grater science and technologies than now. Then we firstly describe a brief history to the idea of method to analyze the grater
science and technologies, secondly expound the methodologies to express and analyze them using the compartment system concepts, finally show the conclusion and the further works.

**Keywords:** the handicapped situation, the information amounts, the philosophical existences, the compartment system.

### **1. INTRODUCTION**

In the previous papers we have reported the essential meaning of the ubiquitous concept. There we have expounded that the essential significance of the ubiquitous idea is in the recovery of lost functions of ordinary persons. In the recent years the concept of ubiquitous system has been popular and popular, but the main stress of the idea have been put on its merit cases and the consideration of its negative phase has not been discussed sufficiently. Therefore authors have made a fundamental element of the essential significance of the ubiquitous concept as clear as the above description. On this essential meaning we have designed and proposed the Life support system involving the communication system able to be used among the handicapped and ordinary persons as a module. This Life support system has been developed from the expanded EMR (the Electric or Electronic Medical Record; such a name as the Expanded EMR has now been adapted in author's papers as the word to be different from the ordinary EMR, but in the future if more appropriate name appears its name will be able to be adapted.). On the other hand we have developed the communication systems and devices for the handicapped persons. The YUBITSUKIYI (which is the name of communication device for blind deaf persons. See Fig.3) system is one of them and a mobile system. This Life support system has this mobile system as a module. Of course, this Life Support System itself has been developed until now and this communication device

and other devices have been developed too. In this paper we discuss the most fundamental and important view points on dynamical situation of such system, and present the ways to the analyzing method of the grater science and technologies than the modern science and technologies considering the information structures and the information amounts of the above described working systems. With regard to such consideration we have discussed three cases of study as the methodologies to derive the new information theories. That is, The first case of them is the consideration of entirely new information concepts different from the ordinary information theory, and the second case of them is the consideration of information concepts on some philosophical view points (for instance, Peirce's semiotics and its interpretants etc.), and the third case of them is the consideration of information concepts on the basis of Fuzzy concepts and expanded from the ordinary Shannon's information theory to the Fuzzy system's idea. In this paper the second case is mainly discussed and on the idea of the second case we explain the methodologies to indicate and derive the ways to the analyzing method of the grater science and technologies. Therefore, firstly the brief history of synthesis of the Life support system is described, there at same time the communication systems and techniques for the blind deaf persons are briefly described. Secondly the discussion of philosophies and existing elements in the philosophical spaces is performed, and Peirce's semiotics and its interpretants etc are briefly expounded. There it is described that introduction of the interpretants into the new information theories is useful, and by expanding this idea we can obtain the methodologies to indicate and derive the ways to the analyzing method of the grater science and technologies. Furthermore as even if the science and technologies are progressed much more by modern material methods they are parts of the nature and cannot overcome it, we have proposed the expanded methodologies. Then thirdly as an example of system to be distributed to the interpretants' model the compartment

system is explained and introduced. There the brief description of general compartment system theory is shown and it is described that the methodology taking account of the compartment system theories is useful as one of the methodologies to indicate and derive the ways to the analyzing method of the grater science and technologies. And finally the conclusion and further works are described.

### 2. THE BRIEF HISTORY OF SYNTHESIS OF THE LIFE SUPPORT SYSTEM AND THE COMMUNICATION SYSTEM FOR THE BLIND DEAF PERSONS

In recent years the ubiquitous concept has become popular mainly on the view point of its merit issues. But this easy promotion of this concept has very dangerous aspects because the humankind uses the ubiquitous system and he has not only the positive mind but also the negative mind. Therefore considering the negative aspects of the ubiquitous idea we have derived the essential significance of the ubiquitous concept, that is; it is in the recovery of lost functions of the human being and the handicapped situations. Then on this essential concept we have developed the Life support system to have been synthesized from the expanded EMR on the base of Linux OS, embedding the communication system for the blind deaf persons. As the communication system and device to be embedded in the Life support system the YUBITSUKYI system has now been used. This YUBITSUKYI system was developed and is now developed for the communication among the blind deaf persons and the others. In today's world there are many blind deaf persons. Therefore the Life Support System to have the "YUBITSUKYI" system as a module has been useful not only for the communication among the handicapped and ordinary persons, but also for the diagnosis of dementia, especially the diagnosis of the blind deaf persons. For in our previous papers we have

defined and treated the dementia situation as a kind of handicapped situation. Now we show the outline of the "YUBITSUKYI" system at the following. It is the system with which the blind deaf persons are able to communicate among themselves and others. The word "YUBITSUKYI" (see Fig.3) is the name of device of this communication system. And this device has been designed on the basis of the Finger Braille that is structured on the Braille patterns (see Fig.1, Fig.2). And the "YUBITSUKYI" system is useful not only to such communication process but also to information processing as the "YUBITUKYI" is the electrical tool (at present having been improved) and the signals of this tools are able to be treated by electrical signal processing techniques and at same time we can directly treat these data as the information processing data. Therefore we need the consideration not only from the engineering and hardware aspects but also from the information transmitting and systems. In this paper, during the study of the information transmitting and systems we discuss the methodologies to indicate the ways to the analyzing method of the grater science and technologies. Now the finger Braille technique is structured on the Braille system (that has the Convex and the Concave sides). The Fig.1 shows a Braille pattern of Japanese character "ka", and its symmetrical expressions of the Braille and the finger Braille. The "YUBITUKYI" system uses such finger Braille patterns, and using the touch sense of the six vibrating points of this system the users of this system are able to transfer and receive the information of such finger Braille patterns and the mutual communications of users of this system are performed. As this "YUBITUKYI" system has been embedded into the Life support system as a module we can use the function of the " YUBITUKYI" system in the use of the Life support system, therefore after this we totally consider the information transferring and systems in the Life support system, but with regard to the module we use usual name the "YUBITUKYI" system.



Fig. 1 The correspondence of Braille and the Finger

### Braille



Fig. 2 The Finger Braille



Fig. 3 The "YUBITUKYI"(Left:Ver.1, Right: Ver.2)

When the users use the "YUBITUKYI" system as devices of the communication system among the blind deaf persons and them, they can communicate through the touch sense of the total 8 vibrating points of those devices. The 2 points in the 8 points are for the functions of transmission of signals and the patterns of Japanese characters are structured by the 6 points that are left. And those patterns are considered as the fundamental information elements. Here, from the Shannon's theory the active state of vibrating points means to arise the events of ON or OFF, and the information amounts of 6 bit show that the set of total  $2^6 = 64$  patterns of Japanese character is the fundamental pattern set. But such Shannon's information theory is not sufficient in order to express the handicapped and dementia situations as some information patterns. Therefore the examination of new information idea over the Shannon's theory has been needed for the analysis of information system of the handicapped and dementia situations and we have discussed the second case above described. There we consider the philosophical elements and derive the new information theories and amounts. [1], [2]

### 3. THE DISCUSSION OF PHIROSOPHIES AND EXSITING ELEMENTS IN THE PHIROSOPHICAL SPACES

Here we consider the Peirce's semiotic, especially discuss the Triadic relations in the Peirce's semiotic. Of course, if necessary and useful, we will examine the other philosophies (for instance, the epistemology of Kant and so on), but at this time we introduce the Peirce's semiotic, especially the Triadic relations in the Peirce's semiotic into our consideration and discuss the methodologies to reach the way of analyzing the new information theories and amounts. Now the Triadic relations in the Peirce's semiotic is explained as the following. That is; "A sign, or representamen, is something which stands to somebody (interpretant) for something (an object) in some respect or capacity". Here, we have introduced this word "interpretant" by Peirce's creation and have used this word into our papers and discussions. As the triadic relations example, such a situation is considerable as a hunter finds such a certain tree as is damaged in a forest and supposes that a deer is in his neighborhood. In this case, as being shown at the Fig. 4, the Triadic relations are able to be consisted of among the "a wound (a sign) of a tree", the "deer (an object)" and the "knowledge / experience (interpretant) of a hunter". And this Triadic relations show a kind of sign process on the Peirce's semiotic. Here, the important facts are that the interpretants arise and converge the final interpretant, and



There is a deer

#### Fig. 4 The Triadic relations in the Peirce's semiotic

in the Peirce's philosophical space these elements exist as well as the events exist in the Shannon's information theory. Therefore from such example of evolution model of a series of interpretants, it is estimated that we can understand the structure of recognition system of human being and derive the quantitative information amount models. Then in order to abstract the new information theories and amounts we firstly propose such a methodology as we introduce such philosophical existences (after this we call such elements as existences.) into the consideration of the new information theories and amounts. And we secondly propose the expanded methodologies to reach the ways to the analyzing method of the grater science and technologies. These methodologies means not only that they are expanded by considering and reflecting the other philosophies, but also that they are expanded by distributing some scientific and technological system models to the philosophical existences. In this paper with regard to the latter we show the example of considering the compartment system models and describe the methodologies to be expanded from the fundamental compartment system models and reach the ways to the analyzing method of the grater science and technologies. And there we consider the methodologies able to be applied for the nervous and brain system from both view points of physiology and functions of these systems too. [1], [2]

### 4. COMPARTMENT SYSTEM AND THE EXPANDED METHODOLOGIES

Here we firstly describe a brief compartment system theory as the following. Namely we assume that the  $x_i$ , (i =  $1 \sim n$ ) in general are the state variables to reflect each compartment of the compartment system. Then, in general the ordinary compartment system is expressed as the following formulas.

 $d \mathbf{x}/dt = \mathbf{A} \mathbf{x}$ , or  $d \mathbf{x}/dt = \mathbf{A} \mathbf{x} + \mathbf{B} \mathbf{u}$ 

Here A is a transfer matrix,  $\mathbf{x} = [\mathbf{x}_1 \mathbf{x}_2 \dots \mathbf{x}_n]^{t}$  is the state variable vector, Bu is controllable term and t is time. Here in order to expand the first methodology we distribute the compartment system elements to the Triadic relations in the Peirce's semiotic, especially to the interpretants. Namely in order to derive the new information theories and amounts we apply the compartment system theory elements to the philosophical existences and expand the original methodology into which the philosophical existences are introduced only. Furthermore we can widely promote the expansion of the original methodology by applying various compartment system models to the philosophical existences. For instance, when we apply the compartment system models able to be analyzed by the circuit and network theory to the philosophical existences we can expand the original methodology to the methodology in which we can use the characters of the circuit and network theory. For instance, see the Fig. 5, here though we omit the detail and some assumptions, the electrical elements are like circuit elements and not the real circuit elements. On the other hand we have studied the characters of the brain functions and nervous systems, especially we have researched the characters of the ABR (Auditory Brainstem Responses).



Fig. 5 The model of the like circuit elements

There we have obtained many important characters of the ABR, and we recognize that we can express the ABR systems (functional and physiological) with the circuit and network models. Therefore if we understand that some relations are between the information transmitting through humankind and the electrical signals to transmit through the brain and nervous system, it is estimated that we can use such expanded methodologies as above described in order to analyze the brain and nervous system characters. And this fact means that we can guess the possibility for us to analyze some unknown principles and characters under the new information theories and amounts and under the brain and nervous systems using such expanded methodologies Therefore if we expand the methodologies with the more philosophical existences and the distributed system elements, we can propose and use the methodologies to reach the ways to the analyzing method of the grater science and technologies. [2], [3]

### 5. THE CONCLUSION AND FURTHER WORKS

In this paper, introducing the philosophical existences we have obtained the original methodology and considering the compartment system concepts we have obtained and proposed the expanded methodologies. And we have shown that such expanded methodologies are useful to reach the ways to the analyzing method of the grater science and technologies. After this we more expand such methodologies themselves, and using them we analyze some unknown principles and characters under the new information theories and amounts and under the brain and nervous systems.

#### ACKNOWLEDGEMENT

We thank much advices and efforts of the IIC members and Dr. S. Kato of Teikyo Heisei University.

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## WEB 2.0 Audiovisual: educational model reference

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### ABSTRACT

We are testing a new educational center in northern Spain. A new educational model integrating visual strategies of Web 2.0 and intending to respond to the demands of the actual society in crisis is being practised at new Integrated Centres. This experience shows the first outcomes resulting from the adaptation of the Spanish educational model to the EAHE: a new Centre of Vocational Higher Education in Information and Communication Technology case study.

Methods: The research puts into practise the new educational model with and about WEB 2.0 ICTs in this Education Centre and confronts the academic results obtained to those from another same centre of the region.

Results: The new Centre in Communication has achieved a gradual increase in the number of students, than tripled since its inception (in 2006 there were 90 students, and in 2009 was 312). In the same way that is making the audiovisual web 2.0, we conclude in the need for bringing the entertainment strategies closer to learning, and showing that the new educational design must review its approach insisting on tasks as the mean to attain educational objectives, training of cognitive analytic and reflexive abilities focus toward the action.

Keywords: WEB 2.0, lifelong learning; media in education; teaching/learning strategies.

### 1. INTRODUCTION

Approaches established by the European Council in 2000 as well as its prospects for convergence in 2010 created a trend supported by Spain whose Education Administrations applied these recommends with special interest in pursuing the guidelines for competitiveness according to standards established by the Quality Assurance Reference Frameworks [1]. By facing a global crisis nowadays, it is necessary to maximize goals: high standards for quality of training, validation and recognition of diplomas in western countries, assimilation of non-formal education, and to facilitate crossborder mobility for people in a global labour market [2].

Nowadays, research and educational systems aim for new regulation of the existing training models in order to respond to the approaches set by a coherent and common European Education Area [3]. Social networks focused on supporting relationships between teachers and between teachers and their students are now used for learning, educator professional development, and content sharing. This is the result of global interests, market pressures, movement of cross-border commuters who overcome geopolitical barriers, and new technological forums for exchange of **visual** knowledge.

| Rank | Site             | Unique Visitors (users) |
|------|------------------|-------------------------|
| 1    | facebook.com     | 540,000,000             |
| 2    | <u>yahoo.com</u> | 490,000,000             |
| 3    | live.com         | 370,000,000             |
| 4    | wikipedia.org    | 310,000,000             |
| 5    | msn.com          | 280,000,000             |
| 6    | microsoft.com    | 230,000,000             |
| 7    | blogspot.com     | 230,000,000             |
| 8    | baidu.com        | 230,000,000             |
| 9    | <u>qq.com</u>    | 170,000,000             |
| 10   | mozilla.com      | 140,000,000             |
| 11   | sina.com.cn      | 130,000,000             |
| 12   | wordpress.com    | 120,000,000             |
| 13   | bing.com         | 110,000,000             |
| 14   | adobe.com        | 110,000,000             |
| 15   | <u>163.com</u>   | 98,000,000              |
| 16   | taobao.com       | 98,000,000              |
| 17   | soso.com         | 97,000,000              |
| 18   | twitter.com      | 96,000,000              |
| 19   | youku.com        | 89,000,000              |
| 20   | ask.com          | 88,000,000              |

Table I. Doubleclick ad planner by Google <u>http://www.google.com/adplanner/static/top1000/</u> (1/may/2010)

The present study describes the response of the Audiovisual Centres of Vocational Higher Education to these approaches. The design of these centres follow the education guidelines developed by the Spanish legislation as well as the proposals made by the European Council of Lisbon in 2000, which sets a ten-year term for Europe to become 'the most competitive and dynamic knowledge-based economy in the world, capable of sustainable growth with more and better jobs and greater social cohesion" [4].

This paper is based on a publicly funded project developed from 2006 to 2009. The development of the research continue with the guidelines within the initial project called *Research and Development for training of teaching and management staff at Integrated Centres*<sup>3</sup> coordinated by the School of Education Science at the University of Oviedo (Spain).

| Phase 1 | Design of the new educational model based on  |
|---------|---|
| 2006    | the new legislation and according to European |
|         | guidelines: new contents, methodologies and   |
|         | school management.                            |
| Phase 2 | Application of multimedia contents and new    |
| 2006-   | methodologies within the new school           |
| 2008    | management framework.                         |
| Phase 3 | Verification and discussion of data           |
| 2009    | development.                                  |
| Phase 4 | Presentation and distribution of results.     |
| 2010    |   |

Table II.- Phases of the research project.

The project started after the creation of the new Integrated Centre in 2005, with new facilities and teaching staff – the Spanish Law of Creation of Integrated Centres was developed, and the academic results obtained were compared to those of another similar public education centre from this region (*Aramo Oviedo*<sup>4</sup> Secondary Education High-school) offering the same training but carrying on its daily activity as a Secondary Education High-school with a traditional approach determined by the former legislation.

#### 2. BACKGROUND

We considered the social background of the students as well as demographic characteristics which define educational policies [5]. The social and cultural background of this Centre is that of a region submerged in a social and economic crisis, targeted for industrial reconversion of mining and transferring the primary industrial activity into services. This region is an example of the aging European population [6], which has an impact on a lack of students and this tendency makes the students become something to be achieved and satisfied [7].

The same European Framework for High-Level Education set out the guidelines for the project to put the innovative methodology into practice, and provided with the teaching autonomy established in the above-mentioned Spanish Law (*RD1558/2005*) which defines a new educational model. This Law was the object of the first research and meetings of the team for this project, making it possible to experience the European Qualifications Reference Framework and to follow the 1999 Bologna Declaration: quality enhancement of education, mobility of teachers and students due to the recognition of diplomas[8].

### **3. INITIAL APPROACH**

Spain has been dealing with the introduction of New Technologies in Education for years (Table 3) and the number of doctoral dissertations in the audiovisual field has been increasing since the academic year 2005/06.

| PhD<br>Dissertations | PhD Since 1976 to 12/2008 sertations |       | Since 2005/06 to<br>12/2008 |       |
|----------------------|--------------------------------------|-------|-----------------------------|-------|
| Informatics          | 115 (20.0%)                          | 53.8% | 19 (20.6%)                  | 33.6% |
| Computer             | 194 (33.8%)                          |       | 12 (13.0%)                  |       |
| Audiovisual          | 128 (22.3%)                          | 46.2% | 23 (25.0%)                  | 66.3% |
| Video                | 137 (23.9%)                          |       | 38 (41.3%)                  |       |
| Total                | 574 (100%)                           | 100%  | 92 (100%)                   | 100%  |

Table III.- PhD dissertations in Informatics and Audiovisual field. (Source: Teseo Spain.)

A quick development brings together audiovisual features with informatics in multimedia web 2.0 [9]. This fact reorganizes basic education terms such as *tool* and *language* as well as forms, concepts, stereotypes and structures of knowledge within the different dimensions of knowledge in an individual [10]. A new approach for a European education institution requires setting singular, different education strategies specifically linked to Multimedia and distance training.

The Department of Education Science (University of Oviedo) provided our project with methodology and all of its professors joined the project since its beginning in 2006, when the Centre was inaugurated. Provided with new technologic audiovisual education-based resources, its high cost involved a predictable optimization and maximization of its performance. Thus, we took into account funding and commitments made: European Structural Funds (European Social Fund) on Economic and Social Cohesion, Convergence, Training and Fight against Unemployment (Programme for reactivating the mining regions 2001-05), being Asturias priority objective no.1 within less-favoured Europe.

Revision of the state of the discussions was made during research considering previous scientific theories about training in ICT-WEB 2.0. This theory reference framework collects training experiences *with and for* devices, where the teacher and his/her activity is the fundamental key in the development and interpretation of these new cultural situations (Bartolome, 2005). Thus, Cabeza [11] says that the incorporation of technological resources may alter contents and sequence of contents so as to result in a different curriculum. We reviewed the reduced synchronic number of similar experiences in the region<sup>5</sup>, in Spain<sup>6</sup> and abroad, where these type of centres are linked to the university field<sup>7</sup>; for these cases, their development and potential link with our present project were revised.

### 4. OBJECTIVES OF THE STUDY

The development with high autonomy enabled an innovative activity in terms of management and pedagogic decisions in order to achieve an ongoing improvement of the educational process itself as well as an adequate use of resources and excellent academic results.

Objective:

- To set out and develop new teaching methodology strategies connected with curricular contents (audiovisual) in accordance with the importance, progress and needs of the background (social/ professional/ European).

In 2008 we observed the academic results from the graduation of two classes of High-Level Vocational Education in Communication, Image and Sound. A positive result of the project is to be considered when objectives are previously set out and implemented. In order to assess the levels of development of teaching strategies resulting from new ICTs, academic results from years 2006/07 and 2007/08 will be compared to those obtained from another similar Education Institution during the same period but using a traditional educational approach without new technological resources. We also measured the accession of graduated students into employment, levels of enrolment in the centre, spreading and application of this methodology in other centres, teaching materials, and literature in the field of science and education published for that purpose.

### 5. METHODOLOGY

Phase 1. - A descriptive method is used in order to revise curricular contents and educational models concerning ICT. The method is based on a documentary revision, description of aspects of the new ICTs as well as the strategies that make ICTs an efficient tool for the transfer of knowledge. This is a study to find its significant variables and causal relations.

We also used the participant observation technique in which the researcher applies the design, he/she is also a member of the teaching staff and makes part of the community observed. It is a method of action research that enriches all the process but involves the need of a proven and permanent verification of outcomes. These demands and conditions were considered as they may question the rigor of the research. We were conscious of the complexity of education phenomena due to their qualitative character which deals with aspects such as values, beliefs or meanings which are non-sensitive to experimentation. Therefore, by following this guideline [12] we had to develop methods under a multi-methodological approach, that is, by using different observers for the same phenomena so as to compare results and attain reliability levels in measurements. We tried to control the threatening level to the internal validity of the research, so individuals with a lower bias estimator participated: new teaching staff, students and management staff who restrict inertia and pedagogic habits which may alter the practice of the new educational model.

In favour of the multi-methodological approach, several simultaneous tools were used for data acquisition together with qualitative techniques of participant observation:

a) – Groups of debate set out on the records of the teacher's meetings where aspects of the subjects proposed for the project were defined and discussed: Potential causes, main characters, hierarchies, interrelations, rules, etc. Alternative strategies and solutions were proposed.

- b) Records and results of academic assessments.
- c) Questionnaires about samples.
- d) Statistic annual reports of the Centre and of the

Administration of education.

e) - Records of the follow-up of the teaching training for the teaching staff.

f) - Reports from the Administration of Education elaborated by inspectors of the education service.

g) - Data resulting from participant observation of the teacher's resources and methodology.

Phase 2. - Practice of the educational design and comparison of results to those from another education institution of control, using a quasi-experimental approach. Samples are students from two public education centres of Image and Sound in Asturias, those attending High-Level Vocational Education at the Integrated Centre (Langreo), and another group of control at Aramo Secondary Education High-school (Oviedo). These groups were already formed and they were considered as equal because variables comprising students' characteristics, number, composition and other aspects were the same, result of chisquare test. We considered the external validity as limited and it must be taken into account that the own Integrated Centres were created as Spanish Education Reference Institutions. Therefore, this experience aims for becoming a model for real and significant practice for the rest of the population, that is, students and teaching staff of Communication, Image and Sound.

We considered the academic results as dependent variable and features that determine them as independent variables resulting from the new training model of the Integrated Centre, established at the Spanish Law (RD1558/2005).

### 6. DESCRIPTIVE ANALYSIS OF NEW EDUCATION STRATEGIES IN ICT

The autonomy for organization and teaching of these institutions and a flexible framework enabled the development

of the educational model, methodologies and contents whose results are described below:

## 6.1. Cultural control of the Multimedia and Audiovisual narrative strategies

What kind of contents, devices and technologies in the web 2.0 are significant in our culture?

We are particularly interested in the function of new social ICTs as pseudo-trainers. The traditional teacher's activity is appropriated and redesigned by integrating a new figure of the teacher in his/her messages, which responds to interests and typical strategies of the great media [13]. We observed that Multimedia narrative techniques and its strategies not only represent a parallel school but also a reference model that seems to be prevailing on the traditional educational model. The effectiveness of these strategies makes its contents to be commonly in daily conversations and creates a specific network of values and counter-values [14].

Knowledge is also managed from new forms, devices and information hypermedia information platforms. This shapes new learning and work methodologies. Thus, these new channels are key elements when it comes to organize learning as shown in the similarity found on most of the messages of social media and streams of opinion. The integration of Audiovisual and Informatics in Multimedia [15] entails a significant change from the paradigm of teaching to the paradigm of learning. This trend benefited from technologic advancements, the increase in broadband communications as well as the integration of different simultaneous resources for the enhancement of the education process and the obtaining of a personalized learning in given environments. Techniques of smart tutoring and study through interactive website – all of them represent new models which are not free either from pitfalls and handicaps.

In the research we measured the frequency of use given to different technologic resources in our students' daily life (Table IV), its good global assessment is emphasized.

| Technology assessed by students     | Use (0 nothing – 10 very much) |
|-------------------------------------|--------------------------------|
| Mobile phone (Voice)                | 8.5                            |
| Traditional TV                      | 7.5                            |
| Work (no entertainment) via network |                                |
| (Internet).                         | 7.4                            |
| Cinema                              | 7.3                            |
| Multimedia phone system             |                                |
| (data+music+video)                  | 7.1                            |
| Photography                         | 7.1                            |
| Multimedia players (I-pod)          | 6.8                            |
| Work (no entertainment) using PC    | 6.5                            |
| Video signal recorder devices (DVD) | 6.2                            |
| Games/ Entertainment using PC       | 6.0                            |
| Handheld video game console         | 3.3                            |
| Video Film                          | 3.3                            |

Table IV. – ICT's preferences. (Source: Personal Research 2007).

Audiovisual messages continue to control every communicative environment. The fact that people spend more than 200 minutes watching TV messages by per day is a correlation that seems to increase in times of crisis when there are 100 minutes spent during a PC session by person during his/her free time<sup>8</sup>. This amount of time is transferred from traditional TV device to audience-made audiovisual formulas; and its messages respond to the interests of the addresser's customers (Shahid and Tang, 2007). That means that people – mainly the youngest – watch every time less generic TV shows and they choose specific programs according to their demands (YOUTUBE, pay-TV channels, on line videos, programs viewed on mobile phone, etc.).

Besides, the 2007 OPA Europe Internet Use At Work Media Consumption Study<sup>9</sup> analyses Internet users from six European countries and stresses reading as the task that users often stop doing as a consequence of the use of the Internet. They also stop (following this order) watching TV, listening to radio and to music. Also, the more common uses of the Internet is the search of news, music, files and software downloads and watching videos on line. Here we realize again the hegemony of the audiovisual field in this new form of cultural transfer.

Therefore, contents associated to new WEB 2.0 must be updated and adapted to the changes suffered by its own devices which determine those contents. These are changeable, dynamic, flexible devices that fit to its users' demands.

#### 6.2. New technologic environments for Knowledge

It was important to follow the European guidelines and to adapt them to the education background and to the particular demands of the society. We affirmed as Eco [16] did, that the introduction of the Internet has an impact on learning and students look up directly the information on the Wiki-Internet instead of using books. Thus, a new subject to be taught at school would tackle the new models for organizing and providing support to information so as to create knowledge.

It seems that traditional audiovisual mediums cannot progress anymore in the field (cinema, generic TV, etc) therefore it has to be studied now as something integrated in networks and in areas of Internet data exchange (WEB 2.0), telematic virtual worlds (MMOs...) with high number of users, etc. All of that thanks to the use of specific broadband which solves the problem of broadcasting for interactive data channels with live image (mpeg 4 compression, etc.).

| MMOs              | Start date | Million of subscribers |
|-------------------|------------|------------------------|
| World of Warcraft | 2004       | 8.5                    |
| Habbo Hotel       | 2000       | 7.5                    |
| RuneScape         | 2001       | 5                      |
| Club Penguin      | 2006       | 4                      |
| Webkinz           | 2005       | 3.8                    |
| Gaia Online       | 2003       | 2                      |
| Guild Wars        | 2005       | 2                      |
| Puzzle Pirates    | 2003       | 1.5                    |
| Lineage I/II      | 1998       | 1                      |
| Second Life       | 2003       | 0.5                    |

Table V.- List of Virtual Communities on the Internet. (Source: gigaom.com June 2007.)

These telematic worlds enable the exchange of information, and they become iconic data in a great way, where the user doesn't have to go out as they simulate that real life. However this virtual world lacks of effectiveness in the treatment of abstract and conceptual contents (e.g.: a philosophic thought) because the image is so powerful that deletes and restricts the content to a secondary position. Primitive gratifying instincts are encouraged (laugh, pity, hurt...) against the capacity for abstraction essential for the development of a reflexive awareness. This new Web 2.0 model for Information Exchange is shown in data from Youtube audiovisual medium (February 2010):

- "Charlie bit my finger - again". Music Audiovisual file played 176 million times.

- "Lady Gaga - Bad Romance". Music Audiovisual file played 170 million times.

- "Evolution of *dance*". *Music Audiovisual file played* 150 million times.

### 6.3. New Audiovisual Educational Model

The Web 2.0 is a global business. The WEB 2.0 contents are introduced under proven successful formulas which have become communicative and cultural patterns worldwide following the guidelines and strategies of marketing (Ferrell and Hartline, 2006). These guidelines rule contents and speech of social communication to make them profitable – therefore during a TV show a CD of music, games, a film coming afterwards or t-shirts of its main characters will be promoted . So, students are often faced with the temptation of attractive activities, which may interfere with the learning task and result in detrimental effects on experience and performance [17].

We see that there is a need for developing strategies that will seek the customer/student and his/her fidelization. This is a response to market economy approaches where supply and demand struggle to find their breakeven point. The models of quality management and management approaches toward the customer [18] have a special connection with these marketing techniques:

- To plan so as to gain markets with limited customers/students who buy their products. The profile of profitable customers is studied and that of minorities is discriminated. Marginalized people and particular ethnic groups are forgotten as far as great strategies concern.

- Clear specification and maximization of tangible objectives: number of customers, sell of products, etc. Efficiency criteria for actions depend on tangible results at the short term.

- Material things are especially valued in detriment of social goods and products.

- These techniques have great power of communication; they use communicative solutions from resources and devices of other systems (theatre-related techniques, radio, music or education itself). Communication is direct and contents and forms are recreational.

Below are shown the aspects of effectiveness of the market strategies used by audiovisual social media compared to those of a traditional educational model. Comparative analysis between the audiovisual model and traditional educational model.

| WEP 2.0 model strategies              | Traditional advestional          |
|---------------------------------------|----------------------------------|
| (references for Audiovisual           | I raditional educational         |
| Centre in Communication               | model<br>(Control Crown)         |
| Image and Sound)                      | (Control Group)                  |
|                                       |                                  |
| Strategies focus on                   | Goals based on help to build     |
| efficiency: data offer,               | knowledge without assisting      |
| entertainment, <b>constantly</b>      | their users or entertaining      |
| assisting users [19].                 | them.                            |
| Messages from a close                 | Teachers seem distant from       |
| distance, colonizing their            | their cultural elite.            |
| daily environments and                |                                  |
| homes.                                |                                  |
| Contents are shown from               | Traditional teachers approach    |
| different sources [20].               | the study of science and error;  |
|                                       | their discourse (assessment of   |
|                                       | effort, perseverance)            |
|                                       | contradicts the messages         |
|                                       | received by the student from     |
|                                       | different media.                 |
| WEB 2.0 discourse is based            | Traditional teachers whose       |
| on iconic forms and limits            | teaching is based on readings    |
| reading to complementary              | and writings.                    |
| forms of expression [21].             |                                  |
| And the Audiovisual model is          | Reflexive abstraction requires   |
| efficient to solve questions          | deep rational thinking,          |
| through images, it is a <i>self</i> - | imagination. It is a             |
| <i>explaining</i> specification -     | comparison between the           |
| elements will be integrated           | typical likeliness of the iconic |
| into the images themselves to         | elements and typical             |
| explain contents- [22].               | cognitive abstraction.           |
| In this sense, audiovisual            | Contents are focused on          |
| media focus on the sphere of          | objective logical thinking.      |
| feelings. fascination and             | deep and extensive analysis of   |
| fantasy [23].                         | data. scientific realism of      |
|                                       | traditional education.           |
| Its procedures are very               | Reality is what matters, the     |
| dynamic and aggressive. It is         | real dimension of problems       |
| performance and                       | and contextualization and        |
| exaggeration what counts              | deepening within phenomena       |
| Enhemeral easy                        | The classroom is a framework     |
| descriptions are provided             | for deep and co-ordinated        |
| creating a superficial mosaic         | knowledge (Winn 2002)            |
| knowledge                             | with thorough studies. Deep      |
| Kilowieuge.                           | and long descriptions            |
|                                       | complex thinking to              |
|                                       | understand the multiple          |
|                                       | dimensions of problems           |
| In the WEP 2.0 the                    | The classroom follows a          |
| III the WEB 2.0 the                   | The classroom follows a          |
| from the ution: the second second     | systematic, structural, lineal   |
| nom the ubiquity with                 | plaining (established in a       |
| random, diffuse                       | series of documents,             |
| presentation. No sooner had           | programmes, etc.).               |
| we observe an earthquake              |                                  |
| than we watched a contest or          |                                  |

| sports game                   |                                 |
|-------------------------------|---------------------------------|
| Goals for media are           | Teachers search for             |
| economic and materialistic at | achievements at the long        |
| the short term together with  | term: development and           |
| immediate solutions (e.g.: if | training of the individual, and |
| the audience buys a certain   | they mainly offer solutions     |
| product so they will be       | for the individual's problems   |
| happy) [24].                  | by using a thorough,            |
|                               | extensive scientific method.    |
| Particularly, audiovisual     | Teachers require a response     |
| media do not require a        | from their audience. Effort     |
| response from its audience    | and deep thinking which         |
| whom receives messages in a   | require great doses of          |
| passive way. It is            | concentration.                  |
| unnecessary to think over     |                                 |
| easy and already assimilated  |                                 |
| messages [25].                |                                 |
| The message is surrounded     | Teachers are sometimes too      |
| by a <b>recreational</b> and  | serious, boring and static.     |
| dynamic sphere.               |                                 |

Table VI. - Comparative analysis between the audiovisual model and traditional educational model.

In brief, for these new media (WEB 2.0) forms are as important as its contents. Messages focus on feelings, on the sensitive and instinctive part of the individual where the *possessions* and the I are valued – happiness at the short term, whereas the traditional educational modelfocus its contents on reasoning [26].

### 8. CONCLUSIONS

The new Centre in Communication, Image and Sound has achieved a gradual increase in the number of students, than tripled since its inception (in 2006 there were 90 students, and in 2009 was 312). It is an attractive educational model in an area in crisis that is losing population.

We conclude in the need for bringing the entertainment strategies closer to learning, and showing that the new educational design must review its approach insisting on tasks as the mean to attain educational objectives, training of cognitive analytic and reflexive abilities focus toward the action. This project propounds the encounter of these two educational models: the traditional educational model and audiovisual narrative model.

This new experience still continues in Asturias, and it is willing to be shared with rest of the Education Community. This project has demonstrated that training in these subjects entail certain features:

- Students require dynamic and updated contents connected to the technological advance of the environment, as social media offer them daily. WEB 2.0 applied to education are dynamics; they develop their own devices, contents, communication techniques and any approach quickly become ancient.

- It is necessary to integrate new strategies to the educational model where new multimedia contents and new educational methodologies are coherent and have a close connection. These new educational approaches do not have a direct impact on the level of academic performance of students but they give an answer to cultural demands, to new technologic devices and forms of knowledge which differ from traditional educational resources and schemes. From this insight, contents, forms and methodologies gain the same significance, and the educational model should use any of the proven efficient strategies being described in the social media field.

### 9.- NOTES

- 1 Law RD5/2002, Qualification and training, (Art. 11.4) Organizes the creation of these centres of Vocational Education.
- 2 Langreo Spain. Email: imagenysonido@educastur.princast.es Tel: (+34) 985678516 www.cislan.es
- 3 BOPA 20-IX-2006 (12-9-2006). Asturias Counseling Education.
- 4 Oviedo Email: aramo@educastur.princast.es Tf: (+34) 985231410 web.educastur.princast.es/ies/aramo/
- 5 I.E.S. Laboral Gijon, I.E.S. Valliniello Aviles, MSP Langreo, y Hosteleria y Turismo Gijon.
- 6 I.E.S. Corona Aragon, I.E.S. Enlaces Zaragoza, XABEC Valencia.
- 7 Center for Integrated Arts Education University of North Colorado.
- 8 December 2008 Nielsen/Net Ratings
- 9 Europe Data, <u>www.opa-europe.org</u>

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Illustration New Centre of Communication, Image and Sound in Spain.

## Measurable Meditation

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### Abstract

Chan is a superior mental training methodology derived from Buddhism. It absorbed wisdom of religious practitioners, philosophers, and scholars around Eastern Asia through thousands of years. As the primary way of Chan, meditation has clear effects in bringing practitioners' mind into a tranquil state and promoting both the mental and the physical health. The effect of Chan is measurable. We propose to establish a Chan science by applying modern experimental sciences to various models that have been used in traditional medicine and philosophical studies. Through these studies, we believe we will be able to make Chan a beneficial practice to promote human's life in modern society.

**Keywords**: Chan, meditation, self-healing therapy; psychology; clinic testing; five elements model, channel model, Buddhism, mental training.

### **1. INTRODUCTION**

Chan (Zen), originated as a methodology of spiritual meditation, has played an important role in the history of Eastern countries. In recent centuries, with the fusion of various cultures in modern society, Chan has drawn attention of various ethnic groups for its focus on practice and direct effect on human's lifestyles and health conditions. While people still use traditional practices ---- meditation in Chan (Zen) centers and/or in religious groups, more and more web based Chan communities have formed that accommodate people from various ethnic and religious population. Chan itself has shown its religion neutral nature in the modern society.

Although Chan is not a typical scientific topic, but it is clearly a philosophy that impacts human's view about the essence of science and relates scientific study to the contemplation of its performer --- human. In recent years, term "life science" has been used to denote studies related to the understanding of human's nature and seeking ways to harmonize human's life with the environments. Applying Chan methodology to health sciences is not only important but urgent.

Chan (or Ch'an ) was named "Dhyāna" in Sanskrit, the ancient holly language of India. The Wikipedia definition of Chan is: Chan is a school of Mahāyāna Buddhism, Chan is itself derived from the Sanskrit Dhyāna, which means "meditation". (<u>http://en.wikipedia.org/wiki/Zen</u>) The literal meaning of Chinese character Chan (禅) is transfer of the sovereign power, derived from the story of the three patriarch emperors Yao, Shun, and Yu. In Chan Buddhism, Chan means the transfer of insightful wisdom.

While a lot of spiritual exercises involve meditation, for example, Yoga, Chan meditation differs from the others in that it emphasizes the acquisition of the insight to one's life so as to be out of the control of any earthly desires and emotions such as anger. In other words, the acquisition of such wisdom (prajna) entails a life of total freedom. Since Chan's goal is the attainment of awakening and enlightenment, it deemphasizes any rational creeds or theoretical reasoning.

The organization of the remaining part of the paper will be as follows. In the second sections, we will present meditation and its therapeutic effects and discuss establishing models to describe its effects and possible ways for quantitative studies. We will give projections on future research directions and concluding remarks in the end.

### **2. MEDITATION**

As the meaning of Dhyana indicates, meditation is an essential part of Chan practice. As a matter of fact, meditation is the primary way to achieve Chan state, although meditation itself is not the goal of Chan.

Chan requires that the practitioners watch their thoughts at every moment, which means that meditation should be carried on alone the entire day. As Bodhidharma said in his famous "On Breaking Forms", "The Dharma way of watching minds embraces all Dharma ways." [1] Meditation with no objects, anchors, or content, is the primary form of the Bodhidharma Chan. The meditator strives to be aware of the stream of thoughts, allowing them to arise and pass away without interference. Therefore, sitting meditation is not the essence of Chan.

However, sitting meditation is still the most important part of Chan practice before one acquires the prajna, since it is the most effective way to regulate one's mind.



Figure 1. Lotus Position

The Wikipedia definition of sitting meditation is: "core aspect of Zen practice, during which practitioners usually assume a position such as the lotus position." (as shown in Figure 1) Various methods were used to regulate the mind. For example, awareness can be directed towards counting or watching the breath; awareness can be put in the energy center below the navel; awareness can be fixed at a picture such as the image of a Buddha or a scene; awareness can also be directed to muttering a Buddha's name, either in voice or silently; etc.

Since Chan is a practice of self control in an everythought level, and its effect is clearly felt, is there a way to measure the effects by scientific means? If the answer is yes, the merit of such measurement is meaningful in many aspects. Firstly, the summarized measurement can verify the teachings of Chan masters. Secondly, it will help regulate Chan practice. Thirdly, it will help build a science for proactive therapy. Lastly but not least, such a science will make religious teachings more tangible and verifiable.

The starting point is measuring meditation.

### **3. SCIENCE ON CHAN**

Probably the most straightforward way to measure meditation is to apply medical technologies to measure the effects of meditation. Such kind of research is suited into the context of medicine research. Generally, two types of research models can be used: statistics models and micro models.

Statistics models are built by applying statistical analysis to collected data from meditation practitioners. Data analysis is done either in the progress of the practice, e.g., comparing the indexes at different points of time during the process; or between different groups, e.g., comparing a group of meditators to a control group.

Current literatures show that both methods are used in the study of complementary and alternative medicine, which includes meditation as one of the methods. In [2], a 20-week contemplative self-healing program was studies. Biologic data were analyzed at the beginning and the end of the program. Research results showed that a contemplative self-healing program can be effective in significantly reducing distress and disability among the testers. In [3], a long-term (5-20 years) project was carried out to investigate the use of complementary and alternative medicine and its effects onto the testers' health.

Comparisons across different groups of people are also found. For example, in a 6-week mindfulness-based stress reduction program, subjects assigned to the program demonstrated significant improvements in psychological status and quality of life compared with usual care [4]. Another comparison is found in [5], where a group of Qigong practitioners were compared to a control group and positive indicators were found in the study.

A survey of the literature on cognitive impairment and cancer presented in [6] suggests that meditation may help to improve cancer-related cognitive dysfunction and alleviate other cancer-related sequelae. Although effects of meditation practice may be more notable among patients, we suggest that more investigations be done in various social groups, e.g., in fitness and sports groups, to fully examine the impact that Chan can bring to modern society.

It is well understood that although statistical study can provide evidence for the effectiveness of meditation, it fails to provide a systematic view of human's epistemology and psychology. This addresses the needs for micro models that depict the inter-relationship between human's mind and physical body. We propose that the systems developed in Eastern studies be utilized to create models for studies on meditation. Such models should serve as the framework to glue findings from experiments and provide a systematic view of psychology.

In the following, we examine some of the models that can be built.

### Five elements model

Five elements theory is an encompassing theory about the composition of the universe and its movements. Together with the theory of Yin (negative side) and Yang (positive side) expounded in "The Book of Changes", five elements theory based the concept of the universe and lives in ancient China. While the theory of Yin and Yang focuses more on the ontology of the universe, the five elements theory tends to describe more tangible sides of the universe and therefore is more adaptable to experimental sciences.



Figure 2. Relationships among Five Elements

Five elements theory provides a categorization of the materials in the universe and their movements. The five elements are: Wood, Fire, Water, Earth, and Metal. Instead of providing an atomic view of the materials, five elements theory focuses more on the properties of the materials and tries to view any substances in the context of their surroundings. For example, the same subject can be classified as Wood in one context but Fire in another context. Therefore, five elements theory is more like a theory of system. The movements of the materials are governed by the creation and control relationships among the five elements. The creation cycle is: Wood creates Fire, Fire creates Earth, Earth creates Metal, Metal creates Water, and Water creates Wood. The control cycle is: Wood controls Earth, Earth controls Water, Water controls Fire, and Fire controls Wood. These two cycles are shown in Figure 2.

A similar model can be found in Buddhism which categorizes materials into Earth, Water, Fire, and Wind. Sometimes another element "Empty" is added to expound Buddhism ontology. This model, however, is mainly used to provide an instantaneous view of the universe instead of give an insight to the mechanism of the movements in the universe. Therefore, Buddhism four elements model is basically not applicable in sciences such as medicine while the five elements model is.

The categorization of materials and movements is shown in Table 1.

|                        | Fire  | Earth  | Metal  | Water  | Wood   |
|------------------------|---|--|--|--|--|
| Yin Organ              | Heart   | Spleen   | Lungs  | Kidneys  | Liver  |
| Yang Organ             | Small<br>Intestine                                      | Stomach  | Large<br>Intestine   | Urinary<br>Bladder   | Gall Bladder                                       |
| Sense Organ            | Tongue  | Mouth  | Nose   | Ears   | Eyes   |
| Tissue                 | Blood<br>Vessels  | Muscles  | Skin   | Bone   | Tendons  |
| Tastes                 | Bitter  | Sweet  | Pungent  | Salty  | Sour   |
| Colors                 | Red   | Yellow   | White  | Blue   | Green  |
| Sounds                 | Laughing  | Singing  | Crying   | Groaning   | Shouting   |
| Odor                   | scorched  | fragrant   | rotten   | putrid   | rancid   |
| Emotion                | Joy   | Worry  | Grief  | Fear   | Anger  |
| Season                 | Summer  | Late<br>Summer   | Autumn   | Winter   | Spring   |
| Environment            | Heat  | Dampness   | Dryness  | Cold   | Wind   |
| Developmental<br>Stage | Growth  | Transformati<br>on                                     | Harvest  | Storage  | Birth  |
| Direction              | South   | Center   | West   | North  | East   |
| Body Type              | pointed<br>features<br>small hands<br>quick<br>enegetic | Large<br>features<br>Strong legs                       | Triangular<br>Features<br>Strong voice                             | Round<br>features<br>Strong<br>digestion,<br>Enjoys<br>Movement        | Tall slender<br>Strong<br>bones and<br>joints      |
| Personality            | Loves<br>attention<br>Talkative<br>Sensitive            | Friendly<br>Calm<br>Generous<br>Caring Earth<br>mother | Meticulous<br>Strong<br>willed<br>Focused<br>worker<br>Independent | Loyal but<br>few friends,<br>Smart,<br>Loves to<br>play with<br>family | Leader,<br>Hard<br>worker,<br>Loves a<br>challenge |
| Out of Balance         | Drama<br>queen,<br>paranoid                             | Worried and<br>over<br>protective                      | Anxious and<br>oblivious,<br>OCD                                   | Fearful  | Angry, mean<br>Cranky                              |

http://www.drstandley.com/readingRoom\_4.shtml

In Chinese medicine, human's organs are categorized into Yin organs (named "Zang") and Yang organs (named "Fu"). As Table 1 shows, Yin organs include heart, spleen, lung, kidney, and liver; and Yang organs include small intestine, stomach, large intestine, urinary, and gall bladder. Heart and small intestine open in tongue; spleen and stomach open in mouth; lung and large intestine open in nose; kidney and urinary open in ear; and liver and gall bladder open in eye. The corresponding flavors are bitter, sweet, pungent, salty, and sour, respectively. Chinese medicine uses symptoms on the sensual organs to diagnose diseases. For example, an inflammable tongue may indicate some problems in heart. The creation and control relationships among five elements determine the relationships among organs as well. For example, when there is a problem with heart, the source of the problem might be because there is some problem with liver, since liver corresponds to Wood and heart corresponds to Fire and Wood creates Fire, a weak liver may not supply heart with the energy in a duly course. On the other hand, the heart problem could be caused by an over active kidney as well, since kidney corresponds to Water and Water controls Fire, and an over active kidney may negatively affect heart's function. The tracing of causes of the problems can go further in the creation and the control cycles. Since Chinese medicine view a person's whole body as one system, the diagnoses and curing of diseases are done in a systematic way as well. A doctor can diagnose illnesses in different organs by examining the odor and color of the coating on the tongue (tongue diagnose) or by checking the strength and regularity of one's pulse (pulse diagnose).

According to Chinese medicine, a healthy state of a person's body is indicated by the balance between Yin and Yang. Here Yin and Yang represent the negative and positive side of a subject, respectively. In medicine, Yin usually means downwardness, intrawardness, inactive, storage, responding, supporting, or deteriorating while Yang means upwardness, extrawardness, active, emitting, activating, exerting, or developing. A well trained meditator should demonstrate a balance of Yin and Yang in his body and a balance in the five element cycles. Therefore, a very essential step in establishing a scientific five elements model should be quantifying the measurement of Yin, Yang, and five elements.

One interesting attempt we found in the literature that involves quantitative testing of five elements was bioresonance therapy. Investigations began in Germany in the 1970's, led to a working model a decade later and now it has presence in over 50 countries nowadays. Bioresonance therapy detects and works with the electromagnetic frequency information continually being generated by human's body. Bio-energetic testing identifies the body's stress reactions to various stimuli and domains. According to bioresonance therapy, "all health problems have a toxic or aberrant energy field frequency in the involved cells. A healthy liver cell has a different frequency than a diseased liver cell in the same person. If the unhealthy frequency can be changed to a healthy frequency and maintained, the cell will heal and become a positive force to all surrounding cells." One of the testing procedures of bioresonance therapy is five elements testing, as shown in Table 2. If an energy imbalance is detected, one can continue the investigation using 10 additional test sets - Allergic Strains; Inhalation Allergens; Parasites & Environmental Loads; Food Additives; Vaccines, Metals & Misc; Bacteria; Virus & Fungi; Degenerated Cells; Teeth; Orthopedics - until the factors stressing the organs are found. (http://terrapintherapy.com/5-Element\_Testing.html)

In Table 1, we can find that five elements theory is also use to model human's aptitude and psychology, viz., emotion, body type, and personality, and, if gone out of balance, what symptoms will be seen from the sicker. For example, a talkative person may be more vulnerable to heart problems because the talkative personality corresponds to Fire as heart does. If we can develop a quantitative five elements model, we may be well suited to measure the seven Latifas (supposed personalities) of Chan practitioners. Interestingly, both the five elements and the seven Latifas have designated colors. In Buddhism, especially Mantrayana Buddhism, colors represent energies.

Table 2. Five elements testing in bioresonance therapy

| FIRE             | EARTH                  | METAL             | WATER                          | WOOD               | Yin-Yang Balance         |
|------------------|------------------------|-------------------|--------------------------------|--------------------|--------------------------|
| 5 FC 001         | 5 FC 009               | 5 FC 019          | 5 FC 028                       | 5 FC 038           | 5 FC 047                 |
| Female hormones  | Stomach                | Large Intestines  | Lower urinary tract/           | Big joints         | Viral strain             |
| 5 FC 002         | 5 FC 010               | 5 FC 020          | Bladder 5 FC 029               | 5 FC 039           | 5 FC 048                 |
| Male hormones    | Spleen                 | Lungs             | Kidneys                        | Small joints       | Bacterial strain         |
| 5 FC 003         | 5 FC 011               | 5 FC 021          | 5 FC 030                       | 5 FC 040           | 5 FC 049                 |
| Heart            | Pancreas               | Bronchia          | Female genitals                | Liver              | Heavy metal strain       |
| 5 FC 004         | 5 FC 012               | 5 FC 022          | 5 FC 031                       | 5 FC 041           | 5 FC 050                 |
| Circulation      | Central nervous        | Skin              | Male genitals                  | Gall bladder and   | Chemical strain          |
| 5 FC 005         | system 5 FC 013        | 5 FC 023          | 5 FC 032                       | ducts 5 FC 042     | 5 FC 051                 |
| Small Intestines | Encephalon             | Connective Tissue | Lymph                          | Fatty degeneration | Disturbed eliminati-     |
| 5 FC 006         | 5 FC 014               | 5 FC 024          | 5 FC 033                       | 5 FC 043           | on ability 5 FC 052      |
| Triple Warmer    | Organ degene-          | Ligaments         | Teeth                          | Muscular system    | Degenerated Cells        |
| 5 FC 007         | ration 5 FC 015        | 5 FC 025          | 5 FC 034                       | 5 FC 044           | 5 FC 053                 |
|                  | Sensory organs         | Tendons           | Paranasal Sinus                | Spine              | Strain intercellular     |
|                  | 5 FC 016               | FC 026            | 5 FC 035                       | 5 FC 045           | tissue 5 FC 054          |
|                  | Metabolism<br>5 FC 017 |                   | Allergic reactions<br>5 FC 036 |                    | Acute strain<br>5 FC 055 |
| Attenuation Fire | Attenuation Earth      | Attenuation Metal | Attenuation Water              | Attenuation Wood   | Chronic strain           |
| 5 FC 008         | 5 FC 018               | 5 FC 027          | 5 FC 037                       | 5 FC 046           | FC 056                   |

http://terrapintherapy.com/5-Element\_Testing.html

When one has got rid of his holding to himself, there will be no separation between him and the surroundings (物我一如). The science we establish through Chan is therefore a science of harmony between life and the environment. In Table 1, we can also find that five elements represent seasons, directions, and changes. A well balanced life should be manifested by one's proper action in the environment as well.

### **Behavioral models**

A Chan practitioner should demonstrate good behaviors and self-control. Measurement of meditation effects can be done by analyzing mental health indicators, e.g., lust, anger, fear, ability of cautioning oneself, balance in personality, etc. Existing psychological measurements can be applied to Chan practitioners against psychological indicators. One example of existing metrics that include psychological indexes is Functional Assessment of Cancer Therapy --- General (FACT-G) [7], which consists of four subscales assessing physical well-being, social well-being, emotional well-being, and functional well-being. Another metric is Profile of Mood State, which measures mood [8].

Famous Zen scholar, Daisetz Teitaro Suzuki (铃木大拙), wrote a book [9] about Zen and psychoanalysis, which gives a Buddhist analysis of the mind, its levels, and the methodology of extending awareness beyond the merely discursive level of thought. In producing this analysis, Suzuki gives a theoretical explanation for many of the swordsmanship teaching stories in "Zen and Japanese Culture" [10] that otherwise would seem to involve mental telepathy, extrasensory perception, etc.

A recent work in Zen and psychotherapy can be found in [11], where the therapeutic value of meditation is principles There are analyzed. six Zen of psychotherapeutic value: acceptance (suffering), fearlessness (courage), truth (enlightenment), compassion (toward self and others), attachment (desire), impermanence (letting go). In addition, Zen is analyzed against the phenomenology of traditional psychotherapy in the biological approach, the learning theories, the cognitive approach, the psychodynamic perspective, and the humanistic approach.

We suggest that five elements model be incorporated into traditional psychology approaches and experimental procedures be applied in the resulting models to continue in the theme of the aforementioned pioneering works. We hope that the five elements model can provide a systematic view in the traditional approaches.

### Progression model

The last, but not the least model can be built from the procedures of meditation itself. Such a model will no longer be suitable for clinical purposes but aiming to be guidance for meditation practice.

The well known four Dhyanas (catvari-dhyanani) theory clearly depicts the procedure of meditation in four series of stages, viz., the first Dhyana through the fourth Dhyana, as described in the following.

- 1) First Dhyana: Bliss Born of Separation
- 2) Second Dhyana: Bliss Born of Samadhi (proper concentration and proper reception)

3) Third Dhyana: Wonderful Happiness of Being Apart from Bliss

4) Fourth Dhyana: Clear Purity of Casting Away Thought

(http://www.bhaisajyaguru.com/buddhist-ayurvedaencylopedia/four\_dhyanas\_sz-chan\_sz-jing-chu\_catvaridhyanani\_jhana.htm)

Each stage has specific state of mind, the realm of sensory perspectives, possible interaction with spiritual beings, and methods to avoid deviations from the right path. In

Sui Dynasty of China, Patriarch Zhi Kai (智凯, AC 523-597), the first patriarch of the Tiantai School (one of the eight primary Buddhism schools), specified the detailed methods of Dharma practice for each Dhyana stage [12] and his methods have been used as the primary methods and/or guidance for meditation ever since.

Detailed descriptions of the four Dhyanas are:

- In the First Dhyana (The Ground of Bliss Born of Separation), one's pulse stops, but this doesn't mean one is dead. This brings a particular happiness which is unknown to those in the world.
- The Second Dhyana is called the Ground of Bliss Born of Samadhi. In the Second Dhyana, one's breath stops. There is no detectible breathing in and out, but at that time an inner breathing takes over.
- The Third Dhyana is the Ground of the Wonderful Happiness of Being Apart from Bliss. One renounces the *dhyana*-bliss as food and the happiness of the Dharma that occurs in initial samadhi. One goes beyond that kind of happiness and reaches a sense of wonderful joy. It is something that one has never known before, that is inexpressible in its subtlety, and that is inconceivable.
- The Fourth Dhyana is called the Ground of the Clear Purity of Casting Away Thought. In the Third Dhyana thoughts were stopped--held at bay--but they still had not been renounced altogether. In the heavens of the Fourth Dhyana, not only are thoughts stopped, they are done away with completely. There basically are no more cognitive considerations. This state is extremely pure, subtly wonderful, and particularly blissful.

It is easily seem that each Dhyana has specific bodily manifestations. For example, one's pulse stops in the first Dhyana and the breath stops in the second Dhyana, and one can anchor his thoughts in the third Dhyana and totally stop thoughts in the fourth Dhyana. With the advancement of modern technology, we can well go beyond these obvious bodily manifestations and give more detailed accounts of bodily manifestations in terms of modern medical terminologies, such as those used in electrocardiogram, electroencephalogram, and magnetic resonance imaging (MRI).

As a matter of fact, four Dhyanas is actually very high achievement level in meditation practice. In Buddhism, the heaven (in its spiritual definition) has three levels (recall 2 Corinthians 12: 2: I know a man in Christ who fourteen years ago was caught up to the third heaven. Weather it was in the body or out of the body I do not know --- God knows.) The three levels are: the heaven with desires, the heaven with dharma, and the heaven without dharma. The heaven with desires in the lowest and the heaven without dharma is the highest. Buddhism's goal is getting out of the three heavens. Therefore, Buddhism achievers, including Buddha, Bodhisattva, and Arhat, are above three heavens. Each heaven is further divided into three levels. Therefore, there are nine levels pf heavens in total. Chan's realm, Samādhi, does not exist in the heaven with desires. Actually, the heavens of four Dhyanas are the highest levels in the nine level heavens.

There are not so many meditators with such high achievements in the four Dhyana levels. As a matter of fact, most of the meditators are even under the lowest level of heaven with desires. It might be more meaningful and cost-effective to test one's proficiency level of meditation using more direct indicators. For example, fearlessness is one of the important psychological indicators of Chan practitioners. As a matter of fact, one is afraid when he loses confidence in his destiny. A good Chan practitioner should be affirmed of his destiny and can control his way of passing away. Patriarch Bai Zhang said: "Coming back from and going forth to death is like door's opening." This is attested by the fact that almost all of the Chan masters passed away and entered Nirvana in a sitting position, sometimes while talking and laughing. Doubting is one of the most harmful barriers in spiritual lives as well as Chan practice. As Buddhism scripture says: Belief is the origin of the way and the mother of good deeds, for it constantly fosters all characteristics of virtue.

Would putting testers on a roller coaster be an easy way to find a clue about how good the testers are in Chan?

We can find ways to test other Chan personalities as well.

### 4. FUTURE RESEARCH DIRECTIONS

Although clinic studies of alternative medicines including meditation are present in the literature, more systematic studies are still in need. The ideas presented in this paper have to be refined and incorporated in clinic and/or laboratory procedures to be fully scientific. Interdisciplinary collaborations will be sought to promote science on Chan.

### 5. CONCLUDING REMARKS

Through thousands years of practice, Chan is tested to be a superior mental training methodology and it is religious neutral and middle way. Its effect, however, is beyond the scope of any theoretical studies. Meditation is the primary way of Chan and there are clearly expounded methods for meditation. Chan pursues a mentality of full freedom and enlightenment. With the advancement of modern experimental technologies, the effect of Chan is measurable and meditations have been studies in clinics. However, systematic science on Chan is still yet to be established. Various models exist and can be used in systematic studies of meditation.

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## SECOND-ORDER CYBERNETICS, SEMIOTICS AND THE ART

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The following figure illustrates the way we proceed to show the methodology used in our examples.



Figure 1 – Adaptation of Pierce's approach of semiotics fundamentals for Second-order Cybernetics's needs

The figure 1 is adapted from ASK Metafilter, robustai.net/mentography/semiosis 2.ipg. for our needs.

### ABSTRACT

We take into consideration the concept of second order cybernetics and Pierce's approach of semiotics fundamentals. I am also an observer, experimenter and mental interpreter of metasigns given to the audience by Eugene Ionesco's absurd theatre. The interpreting of signs meaning is determinate by the context. From Semiotics 'point of view, the objects I'm studying (The short play Foursome and The Chairs) gives me a lot of information about differences or NOT between actors, positive and negative interactions and become knowledge when I see them as signs. Second order cybernetics brings to the semiotics the idea of closure of structural coupling, interpretation and language [Soren, Cybersemiotics]. The YOYO in figure 1 signifies the OBJECT of recursion. Boje [Boje, David, 2005] redefines antenarrative communication more holistically as an enactive phenomenon, and makes connections between varieties of disciplines in order to find out how antenarratives help us understand communication in the world. Instead of the finite event of producing an artifact, **betting** is a process and an end in itself, through which the practitioners gain self-awareness. By synthesizing might enactive-thinking in virtual space and the practice of communicating we appeal for valuable insights into the creative mind, challenging scholars and practitioners alike. Drawing contributions as above ideograms are useful for practicing cyberneticians, researchers statisticians. and academics, Informational Statistics applications [Mihaita, 2010] explores the ways in which liberal arts writers seek to involve, create and engage with new and diverse beginners audiences from encountering and participating in the work unexpectedly, to professionals from other disciplines and members of particular communities. Step by step, in following examples, The Observer is ME and The Experimenter is Myself and also I am The Interpreter. ME as an Observer feedbefore data, observations, facts, concepts, ideas. MYSELF as an Experimenter feedforward wishes and bets or statistical hypothesis and I as Interpreter feedback decision and knowledge.

Keywords — Narrative, Antenarrative, Noncommunication, Informational Statistics, Hidden, false, Illusory or Real interacting Relationships.

### THE SURPRISES OF RELATIONSHIPS SYMMETRY IN ABSURD THEATRE

Knowing that the aim of Informational Research (IR acronym) is to advocate, promote and provide a recognized methodology for current and emerging IR. including research into narratives. antenarratives, communication processes, methods, concepts, aesthetics and style. Through exemplary scholarly research, future round tables, seminars and workshops will present IR as a vital and viable discipline that explores information technology, questions and develops cultural and social practices, and interrogates and affirms philosophical and human values.

In figure 2, as OBSERVERS (coded Obs.), we absorb data, concepts, and signs in Pierce's philosophy of Firstness and as inputs (coded I) in the cybernetics approach. Data and signs are finding and signaled in huge numbers from external visible and invisible environment coded N+S from noises and signals or signs. In another illustrated case [Mihaita, 2010] signals came from the environment as works of the great Poet Eminescu, Eugene Ionesco's Absurd Theatre, or/and we used David Boje antenarrative approaches as bets concerning several paintings with the same subject of the Painter Manet [5]. When we chose the OBJECT of study, following the same Peirce's concept of Secondness, we are looking for distinction between out OBJECT as a viable system in his environment meaning autopoiesis. The distinction we interpret as information comes from differences, constraints and interactions.



Figure 2. Cybernetics approach

As OBJECTS, we took the longest Love Poem *Luceafarul* (translated as Lucifer or Evening Star) of Eminescu, short play *Foursome* of Eugene Ionesco's Absurd Theatre and Manet's paintings in David Boje's interpretation and define the BET's hypothesis. These are at least for us, metasystems

which we observe and study and they are autopoietic systems, because the person who creates the OBJECTS cannot be separated from their creation and we, as observers, are in this metasystem.

As EXPERIMENTERS (coded Exp.), we used Shannon's Information Theory and Onicescu's Informational Statistics. For simplicity and clarity but also for Onicescu' life philosophy we prefer the concept of informational energy as a measure and in the same time a very useful metaphor. The concept, combined with Wiener's cybernetics connects to thermodynamics and redefines information as negentropy.

Also, as experimenters we interpret this autopoietic metasystem in what Brier [1] challenged us with the new term of signgame in Peirce's Thirdness concept. Why doing that? Because global system described with state vectors (vectors structures) give very little information normally measured with statistical tools (average and variances).

Important as experimental data was in case studies the number of signs as presence or actions described into distiches or scriptlines and/or narrative stories. As INTERPRETANTS, we done in this MegaState, with the same Pierce's concept of Thirdness, mediation between hypothesis as BETS (in David Boje's antenarrative concept), new developments concerning systems's realization of itself, its subjectivity, self-value and semiosis.

Even in an era which has seen many forms of artistic creation becoming digitized, the practice of sensing, in the traditional sense, has remained constant. However many discussions about the relationship between sensing and virtual perceiving rely on discipline-dependent distinctions to discuss the activity's reality function.

Boje redefines antenarrative communication more holistically as an enactive phenomenon, and makes connections between a variety of disciplines in order to find out how antenarratives help us understand communication in the world. Instead of the finite event of producing an artifact, **betting** is a process and an end in itself, through which the practitioners might gain self-awareness. By synthesizing enactive-thinking in virtual space and the practice of communicating we appeal for valuable insights into the creative mind, challenging scholars and practitioners alike. Taking into consideration the Second-order Cybernetics's paradigm, any playwriter or painter is an autopoietic system (auto=self, poietic=creation). He is an Observer of his environment, in my case study he could be Eugène Ionesco and Samuel Beckett or Manet in real Crises situations.

As Experimenter he is writing short plays as *Foursome* or plays as *Chairs* or *Waiting for Godot* or paint many times the nearly the same Manet's *Execution of Maximilian*.

As Interpretants of the above works they give answers to questions and sometimes surprise with them. Could be something hidden behind what we see, hear or read? Could be some coding and quantitative methods and measurements reveal something new or an palimpsest as a negative reflection (*Chairs* versus *Foursome*) of Eugène Ionesco's Absurd Theatre?

Myself as **Observer** chose playwrights, painters and study they in them Second World War environment or Napoleon III Empire. Also I look for narratives and opinion about themselves or others (reflexivity).

As **Experimenter** I used System's Theory, negentropy, informational correlation coefficients and find out state vectors' structure couplings, positive and negative interactions over the plays or a vast mass of antenarratives. As Experimenter I bet on statistical Hypothesis occurrences.

As **Interpretant** in sense of Semiotics I look for meaning and found out some logic in the Absurd Theatre. Instead, the theme of the play *Foursome* we find out using Informational Statistics and other quantitative methods, that contrary as in *The Chairs*, on *Foursome* the actors make the Ionesco's concrete void, the visible invisible, developing in our interpretion a negative palimpsest of *Chairs*. We believe that they (players) lives only in **ONE**'s imagination and not feel the **Grand Illusion**.

### INTERDICIPLINARITY IN INTERSTITIUM WITH SCIENCE 2 METHODOLOGIES

Following Saussure's interest in a structural analysis and in Peirce's methods for analysis of text, this chapter offers a new methodology capable of exploring both normal and post-normal science contexts through their respective narrative and antenarrative texts. In particular, it does this through the examination of narratives and antenarratives. The methodology adopts fuzzy cybernetic modeling and Informational Statistics, applied to antenarrative texts Manet's fictional like Execution of Maximilian. Following [Boje, 2], sociocultural life and the arts are reflective of each other. By combining the planning of statistical experiments with Informational Statistics the creation of a fuzzy membership function is possible that offers a new approach for antenarrative analysis that is independent of initial conditions. This approach also allows new arguments to be obtained by measuring the informational gains to be discussed in appear in art, literature or conversation.

Taking into consideration the SECOND-ORDER CYBERNETICS's paradigm, any playwriter or painter is an autopoietic system . He is an **Observer** of his environment.

As **Experimenter**, for example, Eugène Ionesco is writing short plays as *Foursome* or plays as *Chairs*.

As **Interpretant** he give answers to questions and sometimes surprise with them. Could be something hidden behind what we see, hear or read? Could be some coding and quantitative methods and measurements reveal something new or an palimpsest as a negative reflection (*Chairs* versus *Foursome*) of Eugène Ionesco's Absurd Theatre?

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As **Interpretant** in sense of Semiotics I look for meaning and found out some logic in the Absurd Theatre.

We take into consideration the concept of SECOND ORDER CYBERNETICS and Pierce's approach of SEMIOTICS FUNDAMENTALS.

I am also an OBSERVER, EXPERIMENTER and MENTAL INTERPRETER of **metasigns** given by Eugene Ionesco's Absurd theatre. The interpreting of signs meaning is determinate by the context. The objects I'm studying (The short play *Foursome* and *The Chairs*) give me a lot of differences between actors, interactions and become information when I see them as signs.

SECOND ORDER CYBERNETICS brings to the semiotics the idea of closure of structural coupling, interpretation and language [Soren, *Cybersemiotics*].

In analyzing Foursome we define several state's structure. Beginning with actors-performers communication to each other or simply their presence on stage, or reducing only for two alternatives. We need to use dichotomy a procedure very used in Semiotics for various reasons. First at all, because we explained relationships of zero, first and second order by statistical experimental plans as factorial experiments with three factors /variables /attributes / characteristics at two levels and one replication. Second reason was that we was not satisfied with finding strong or feeble relationships but we was looking for hidden, spurious or false ones. The third variable, Stafford Beer teach us, could be of control only, or intervening variable.

So we measure the informational power of relationships with INFORMATIONAL ENERGIES (NEG-ENTROPIES), correlation and informational correlation's coefficients. By some methodologies we find out the nature of relationships and can reduce variability to essential variables. From second-order cybernetics point of view it was more useful to take environmental variety in consideration. Eugène Ionesco's ability as Absurd Theatre's father was his performance to adapt and absorbs environmental variety. His short plays could be understood better as viable subsystems. The Play is a live organism, reproducing every times with a lot of different meanings. People from the auditorium usually said I need three days to understand something or I need to see it twice to understand something.

The goal of *Foursome's* analysis was to verify what struck us initially when codifying different replicas (script lines) and looking for relationships between play's characters because of the repetitive YES/NO attitude. We applied recursion as a necessary principle to reduce complexity and ambiguity of interpretations. Using different recursions we try to find what Stafford Beer in "Platform for Change" understand as REQUISITE VARIETY. (see subtle information from ideograms and channel capacity We illustrated as YOYO our study's object exactly from this reason, meaning that it is given a direction, speed and when is coming back goes again for a new task.

In the short play Foursome everything started with simple and conditioned contingency tables. On rows and columns existed several states. Using Informational Statistics we have measured the influences of one behavior structure over the other and we obtain informational gains given by one detailed structure over several ones. Then we use only dichotomies for experimental planning with factors at two levels and replication and Informational Statistics for identifying the nature of correlations between them In studying and interpreting the results, we like to accept the logic of unfolding changes.

The first recursion is based on coding, arithmetic and EXCEL application with pivot tables, the next on information technology and the subsequent is based on analytical tools as Lagrange or finance portfolios. We used also classical punishment and reward techniques making sure that mentioned unfolding, which surely reduces the internal variety will also provide the context for best use of the internal variety to generate value *Foursome* as a play organization. These recursions was used for variety reduction in for our surprise the story without apparent communication transform in one possible alternative created from the Eugène Ionesco's sub consciousness.

As an **Observer** of Poetry World in general and of Romanian Geniuses Eminescu, I am aware that

there are billions relations between variables, composed functions, and a composing of functions. The scientist trying to understand these phenomena has to try first to understand the poetic of Eminescu's world. He, as Petru Cretia is cited in [Mihaita, 6] is *"having a personal, secret world of his own, for a solitaire experience. Full of shadows, amazing piercing and strange stagnations, full of insisting and rebornings who's insides laws lets itself rethought sometimes. A labyrinth of mirages, echoes and mirrors, of forgiving of massive constructions and ruins on which they left their prints and moments and the time of this world and the other world."* 

As an Experimenter, I tackle with the Legend of the Evening Star or Lucifer (in the Poem "Luceafarul") build by a story about a young princess who prayed to the evening star each night (feed-before information). If we still judge from outside, statistically, both reactions, we get to a fundamental point, experimentally, and that is trying to detect a signal in a noisy environment. The whispers of nature, sea, forest, winds have to be differentiating from the lovers' whispers.

The decision maker wishes to find out if the results obtained with an experimental treatment are so much different of what is going on in its absence to decide if the experimental variable is efficient. Usually we trust the data if the independent variables produce expected reactions. In this case we recognized as recursion figure 3 where the signals, in our case Catalina whispering, is treated by Lucifer as input as he experience by changing himself (feedback), interpret, make mistakes (feedforward expectations, dreams), receive information or requests(coded I, be mortal as myself said Catalina) or critics from Demiurge (C from critics) and deliver knowledge (K).



Figure 3. Signal as input, knowledge as output.

He shall decide this fact by comparing the level of noise variation, by analyzing the data in and without the presence of the treatment. We have to make a difference between the background noise and the one made when the signal is present. We must make a distinction between the combination of **noise** + **signal** and the noise itself asking ourselves about the probability of the event to take place if it is only noise. Hyperion heard a sure level of noise coming from Earth. Some noises or whispers could have been a call. The whispers as *noise* were above the background noise and could have been calls. We can imagine what could have happened when Cătălina would have said you are my love. Then with great chances, the event love would have taken place, but the presumed error of type II: once a mortal, the relationship accepted by the easy Cătălina, to be temporary.

Technically, we are interested by an algebraic report between the heard whispers and the natural whispers. If the whispers are mistaken or they are at the same level with the usual noise, then the algebraic report is 1. If the noise is different than the usual, the report is bigger, in which case, if it goes above some level of knowledge the reaction takes place – the appearance of the beautiful Lucifer. For the expert there is a relation defined as observation / the estimated error. As a result we can look at the treatment and the control conditions that are opposite to the differences that are notable without treatment. If the (signal + **noise**)/ **noise** ratio is sufficiently large beyond the **noise/noise** ratio, then we can conclude that there is that something called a signal: in our case this is the whispers/noise ratio. The evening star falls in love with her and is willing to give up his immortality (feedback reaction), fly thru universe looking for Demiurge to ask for his mortality (feedforeward) who deny the mortality's request (feedback) and Lucifer realizes that the pure love he has for the young girl cannot be sustained in the mortal world (feedback)".

Appears on Web that The Poem can be simply described (for the today's YouTube generation...) as a combination between "Gone with the Wind" (which is a romantic drama), "Star Trek" (because of the Lucifer' flight thru universe looking for Demiurge that contains science fiction entertainment) and "Love Story" (because the world record judges said the Poem is one of the most romantic poems and it also ends in a drama) - all together, which means it is a romantic poem but also a third millennium modern poem.

### CONCLUSION

EVENING STAR POEM is one very good example of narration starting with beginning, content, end. Contrary we tackled with antenarrative short plays of the Absurd Theatre and find probable hidden narratives. In the theme of the play *Foursome* we find out using Informational Statistics and other quantitative methods, that contrary as in *The Chairs*, on *Foursome* the actors make the Ionesco's concrete void, the visible invisible non-communication but understanding.

In this article we apply interstitial methodologies and obtained results that are very promising for analyzing any communication, narrated or antenarrated that has a form of a conversation and make statistics useful in dealing with conversation analysis. Using it to map out other opinions, or real life situations, real life reports, other pieces of literature as Poetry or Absurd Theatre. Just to see what outcomes one gets.

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### New Ways of Educational Science in a Frame of the Science 2

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#### ABSTRACT

The substantial intentions of educational system based on a paradigm shift of education are presented: new adapted structure of content knowledge and educational content according to cognitive architectures of key concepts and knowledge in context of educational communication, deeper study of mental conceptual knowledge systems/mental conceptual models of pupils and students, their exact visualization by means of schemata, diagrams, concept and cognitive maps, integration of newest tools of cognition in the educational content, an individual approach to each pupil and student from the first year of education.

**Keywords**: paradigm shift of education, content knowledge, educational content, cognitive architecture, conceptual model, conceptual knowledge system

#### **INTRODUCTION**

I try to formulate several findings from a scientific point of view in relation to practical applications of scientific models in practice of publishing – based upon questions of editors, designers, and textbook managers. The questions are as follows:

- 1. How can we adapt a structure of scientific conceptual knowledge systems to a cognitive level of pupils and students?
- 2. How does a mental structure of conceptual knowledge systems in students' minds really look? What are primarily authentic pupils' and students' beliefs, notions, and preconceptions?
- How can we visualize the structure of adapted scientific conceptual knowledge systems in curricular materials – in knowledge and learning objects – in relation to mental models of pupils and students?

**Traditional educational science** doesn't answer all above questions because of it is very often a **school science**. It means no emphasis on real problems, e.g. why students don't prefer physics or don't understand physics; why students' concepts and knowledge don't comprise coherent structure; why their knowledge are not applicable in practice, etc. The school science try to solve school problems, e.g. "How to attract student to my course of physics?"

The educational science of the  $2^{nd}$  generation can answer because of several new features:

1. Mental concepts and knowledge of pupils' and students' are not accessible to direct observation, but we can create

models which may be based, e.g., on a cognition of scientific or common language conceptual systems. Because of outside effects produced by the mental conceptual knowledge systems, we can test, modify, and verify or reject our models. This scientific method is usual in modern science and David Hestenes describes it very clearly: "Science comes to know objects in the real world not by direct observation, but by constructing conceptual models to interpret observations and represent the objects in the mind. This epistemological precept is called Constructive Realism by philosopher Ronald Giere." The 'true' model means a model connected by operational assignments to activities produced by mental models, concepts and knowledge if the activities correspond to the observation [4]

2. The transdisciplinarity of the 2<sup>nd</sup> generation's educational science means an involvement of scientific approaches from cognitive linguistic, quantum mechanics, topology, etc. The transdisciplinarity is related to a conception of educational communication of science that is carried out by the curriculum process, which is a sequence of variant forms of curriculum mutually interconnected by curriculum transformations.

New tools of scientific thinking in natural sciences, revealed in the  $20^{\text{th}}$  century, brought new structural approaches to human conceptual knowledge systems that are understood as complex structured systems – nets, which can be visualized by graphs with nodes and edges or as concept, semantic and cognitive maps for purposes of instruction and learning.

### THEORETICAL MODEL: EDUCATIONAL COMMUNICATION OF SCIENCE

The theory of science education concerning the process of educational communication is described by the communicative conception. The communicative conception of science education means the continuous transfer of the knowledge and methods of science into the minds of individuals who have not participated in creating them. This process, called the educational communication of science, is performed by various educational agents – teachers, curriculum makers, textbook designers, university teachers, educational scientists and does not mean only a simple transfer of information, but it also involves teaching and instruction at all levels of the school system, the study, learning, and cognition of pupils, students and all other learners, the assessment and evaluation of learning outcomes, curriculum composition and design, the production of textbooks and other means of educational communication and, in addition, university education and the further training of

teachers. The theory of science education concerning the process of educational communication deals with the scientific conceptual knowledge system of a given science. This conceptual knowledge system (CKS) takes several variant forms during the course of the educational communication of science and it passes through several knowledge transformations. Science education has to follow a complete path of transformations and forms of scientific knowledge, and, in the process, the variant forms of the conceptual knowledge system of science correspond to qualitatively distinct phases of curriculum process. The curriculum process in science education as the complete continuous transfer of scientific knowledge and methods into the minds of learners is realized by means of the sequence of variant forms of curriculum P0 - P6 (as phases of the curriculum process) that are mutually interconnected through curriculum transformations CT1 - CT6. The first and only "non-curricular" member (P0) of this sequence is the scientific system of a given science. Two transformation lines move through the curriculum process: the first of these lines is the sequence of the phases of curriculum process P0 - P6 (variant forms of curriculum) that are interconnected through curriculum transformations CT1 -CT6. The second of these lines is the sequence of variant forms of conceptual knowledge systems (CKS) that are interconnected through knowledge transformations KT1 -KT6. The CKS are also called the content knowledge (CK) of a given science/subject in phases 2-5 [1, 2].

### Phases of Curriculum Process and Curriculum Transformations (CT)

#### $CT1 = scientific system \rightarrow conceptual curriculum$

The scientific conceptual knowledge system (SCKS) of a given science is usually fully comprehensible only to scientists. Therefore the **communicative transformation** adapts the SCKS to ensure its communicability to those who create the next phases of the curriculum process. The communicative transformation creates the **communicative scientific conceptual knowledge system**. The next step is the **conceptual transformation** – the selection and arrangement of knowledge to be transmitted to pupils and students from the light of the beginning educational conceptual **curriculum** as the **conceptual model** of the SCKS – the conceptual model of science.

**Phase P1: The conceptual curriculum** for science consists of two components:

- the conceptual model of science which involves the communicative SCKS;
- the conception, aims and objectives of education following from the BEC.

#### $CT2 = conceptual curriculum \rightarrow intended curriculum$

The conceptual model of a given science is the subject of cognitive analysis, synthesis and adaptation to the cognitive level of learners during the **intention transformation** CT2. This transformation creates an **intended curriculum** as the phase P2 of the curriculum process, which consists of three components:

- the **intended form of CKS** (content knowledge of a given science or draft educational content) adapted to the cognitive level of learners and with regard to the aims and objectives of education.
- the conception, aims and objectives of education,
- information about the cognitive level of the learners' concepts and knowledge.
- CT3 = intended curriculum  $\rightarrow$  project curriculum

During the **project transformation CT3**, the intended form of content knowledge is transformed into a definite educational content (educational form of CKS) with respect to the objectives and goals of education and in the relation to instructional forms and methods. **Phase P3** is the **project curriculum** – the educational project that consists of five components:

- the educational form of CKS (content knowledge or educational content of a given subject) consists of educational programs, the syllabus, knowledge standards, and basic lesson plans. It is concretized in textbooks and other means of instruction.
- the objectives and aims of education,
- the planned and recommended methods and forms of teaching,
- the planned and recommended methods and tools for detection, assessment, and evaluation of learners' knowledge and skills,
- the competencies and qualifications of teachers,
- the organization and conditions of the entire educational system.

## CT4 & CT5 = project curriculum $\rightarrow$ implemented curriculum

The transformation CT4 & CT5 is the educational process which consists of the teaching, learning and assessment of knowledge. The teaching and instruction comprise an operational transformation (CT4) which leads to the realized form of the CKS (or content knowledge). This phase of an actual instructional process is described by the operational curriculum (phase P4). The learning of students leads to the implemented form of CKS that consists of the internal conceptual knowledge system of learners after the process of education. This stage of curriculum process is called the implementing transformation (CT5). Phase P5 is the implemented curriculum – the outcomes of education and their assessment which consist of three components:

- the implemented form of CKS (or content knowledge) the internal conceptual knowledge systems, competencies, skills, and attitudes of learners after instruction and learning,
- the knowledge standards, and
- the methods for the detection and assessment of knowledge, skills and competencies.

#### CT6 = implemented curriculum $\rightarrow$ attained curriculum

CT6 is an **attaining transformation** of the outcomes of education into applicable outcomes of education (knowledge applicable in practice). **Phase P6** is the **attained curriculum** which consists of three components:

- the **attained form of CKS** learners' knowledge, skills and competencies which are applicable in practice,
- the applicable knowledge, skills and competencies standards, and
- the methods for the detection and assessment of applicable knowledge, skills and competencies.

### **Curricular components**

The variant forms of curriculum consist of multiple components:

- **the conceptual component** comprises the philosophy, conception, aims, objectives, and goals of education,
- **the content knowledge component** comprises the variant forms of conceptual knowledge systems of science that are also called the content knowledge of a given subject in the phases 2 5,

- the methodical component comprises the methods and forms of teaching and instruction,
- **the efficiency component** comprises the methods and tools of detection, assessment, and evaluation of knowledge, skills, and competencies,
- the cognitive component comprises knowledge of cognitive psychology and science used in the curriculum process (concerning the perception and cognition of learners in the instruction process, structure of concepts and knowledge to be taught) and also information about the cognitive level of the learners' concepts and knowledge, methods of adaptation of scientific knowledge to the cognitive level and input knowledge of learners,
- **the pedagogical component** comprises the pedagogical content knowledge of teachers, curriculum makers, textbook creators and designers, and also the pedagogical knowledge concerning the teaching, instruction, learning, and
- **the organizational component** comprises an external organization of education (kinds of schools, organizational forms of education, financial and legal components of educational system, etc.) is the empirical. The levels of the scientific concepts are the exact and formal.

### PARADIGM SHIFT IN EDUCATION

Several important features characterize scientific thinking which leads to new discoveries: chunking, the seeking of relations, the building of structures, imagination, and visualization. Mankind survives because "we have evolved the ability to 'cut up' that world into chunks about which we can think and hence give meaning to" [3]. The process of chunking and then seeking the relationships between these 'chunks' as a part of cognition (especially scientific cognition), is modeling, and the products of these mental actions are called (scientific) models. Scientific knowledge as a result of the cognitive process of a scientific community is characterized by a system of scientific concepts, terms, facts, laws, and principles and the connections between them which comprise theories and their applications and interpretations in reality, and cognitive, modeling, application, and interpretation methods and procedures that the given science makes use of. Scientific conceptual knowledge systems are organized in scientific models described by words, symbols, or figures which comprise patterns. Mental patterns have to be visualized in order to communicate them to other people.

### Tools of Cognition in the 20<sup>th</sup> Century

Gilbert [3] speaks about visualization as making visual representations of mental scientific models. According to Hestenes [5], "Mathematics has been described as the science of patterns. Natural science can be characterized as the investigation of patterns in nature. Central to both domains is the notion of model as a unit of coherently structured knowledge. The Modeling Theory is concerned with models as basic structures in cognition as well as scientific knowledge.' Imagination has proven to be a very important ability in which one can find out new features of explored systems, the relations between their elements, etc. "Mathematician Jacques Hadamard surveyed 100 leading physicists and gives an introspective account of his own thinking. He documents two major facts about mathematical thinking: at the conscious level, much of it is imagistic without words; and, much of it is done unconsciously, with clear insights or solutions emerging with 'sudden spontaneousness' into conscious thought. He does not discriminate between the thinking of mathematicians and physicists. He quotes from a letter by Einstein: The words or the language, as they are written or spoken, do not seem to play any

role in my mechanism of thought... The physical entities which seem to serve as elements in thought are certain signs and more or less clear images which can be voluntarily reproduced and combined" [5]. According to Carl Wieman [6], recipient of the Nobel Prize in Physics in 2001, "novices see the content of physics instruction as isolated pieces of information - handed down by an authority and disconnected from the world around them - and that they can only learn by memorization. Experts i.e., physicists - see physics as a coherent structure of concepts that describe nature and that have been established by experiment. To the novice, scientific problem-solving is just matching the pattern of the problem to certain memorized recipes. Expert problem-solving involves employing systematic, concept-based, and widely applicable strategies. Since this includes this problem-solving being applicable in completely new situations, this strategy is much more useful than the novice problem-solving approach."

"Science comes to know objects in the real world not by direct observation, but by constructing conceptual models to interpret observations and represent the objects in the mind. This epistemological precept is called Constructive Realism by philosopher Ronald Giere." [4]. The 'true' model means a model connected by operational assignments to activities produced by mental models, concepts and knowledge if the activities correspond to the observation.

## Visions – main intentions of the paradigm shift in education

The educational science of the  $2^{nd}$  generation may lead to the paradigm shift in education characterized by **specific visions** as **new intentions** of the educational conception. The **substantial and main intentions** are as follows:

- New adapted structure of content knowledge and educational content according to cognitive architectures of key concepts and knowledge (Tarabek, 2010). The adaptation is described in the theory of the educational communication.
- Better and deeper study of mental conceptual knowledge systems/mental conceptual models of pupils and students (covering also naive beliefs, preconceptions, and misconceptions), their exact visualization by means of schemata, diagrams, concept and cognitive maps, etc.
- 3. Integration of newest tools of cognition in the educational content will lead to better quality of students' cognition skills.
- 4. The natural children's curiosity can be a basis for development of features of scientific thinking, especially in thought processes of gifted children. Therefore an individual approach to each pupil and student from the first year of education is needed because of wider class of gifted children as it is normally defined. The wider definition of gifted children covers the children intellectually gifted, communicative gifted, manually gifted, science/technically gifted, etc.

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### System thinking in a hybrid and networked context

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The world is currently facing a process of hybridization of man and technology, organization and technology and society and technology. A process which requires a new way of thinking, a new form of ontology, based on hybrid systems. The philosophy of phenomenology provides us with a basis for such an ontology of hybrid systems in the tradition of Heidegger (1927), Merleau-Ponty (1945) or more contemporary- Ihde (2002;2009). Hybrid systems are developing an increasing need to be interlinked, enabling them to exchange and share information. Interoperability, defined as the possibility of exchanging and sharing information between systems, I have outlined in earlier publications (2010) based on the social systems theory of Niklas Luhmann (1995). When different kinds of hybrid systems have the ability to exchange and share information, they are also capable to connect to each other and form coalitions or networks of hybrid systems. According to Von Bertalanffy (1969), who defined systems as elements being in interaction, these post modern hybrid systems can be seen as systems 2.0. Within systems 2.0 the 'post'human constructs his social reality based on the possibilities of the technologies, which in the future will no longer be visible or will form an integral part of his environment.

This information revolution raises questions about the traditional form of organizations and institutions, and with it the existing command and control structures. Traditional and vertical structures will slowly but surely have to be changed into more horizontal structures that are oriented on the exchanging and sharing of information within temporarily coalitions or networks. The information revolution also raises questions about the agency shift between man and machine and the necessary trust between participants within these kinds of networks. It will surely not come as an surprise that I am envisaging that the scale will tip in favor of technology, with man losing out.

More fundamental questions arise, if with this development to connect more entities and systems in coalitions or networks, these connections can be the beginning of an evolutionary step for society and the organizations within it. Humans will then no longer be the central point for the exchange and sharing of information; more and more they will only be one of the nodes within the network.

Are or will we become part of an developing and unnoticed process of evolution 'from primitive beginnings' as Kuhn (1996) has stated? And will this development determine our further evolution as posthumans, based on knowledge which is hidden in the program code of the systems which we are connecting in the here and now? If we want to get a grasp of the quality of organizations and institutions and the networks they are part of, we have to give priority to their processes, the way they move, their impulses and their directions and rely much less on measuring where the organization stands. The ultimate question which arises from all of this is: will there be somebody or something in the end having the power on the network and the connections and information within it? Can we influence who or what will this be or have we to bow to the virtual world in which we then live?

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### **Daylight Design and Analysis of Y House**

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### Abstract

The paper describes the daylight simulation of Y-house for the competition of Solar Decathlon 2011, USA. Daylight factors and daylight illumination levels in the paper are of great importance to analyze the interior daylight environment of Y-house. Through detail description in the text, the proceeding steps for the analysis of daylight report the simulation method systematically. With the software, the data of daylight simulation is described in 3D model clearly and directly. The suggestions from the result of analysis enable designers and engineers to make a comparatively reasonable decision for the renewal of architecture design and lighting design. With the assistance of software, the design for house, especially the lighting design, and the calculation of daylight factor and daylight illumination levels will support the achievements of the projects, not only Y-house.

**Keywords:** Daylight, Daylight Factor, Daylight Illumination Level, Lighting Design, Daylight Simulation

#### 1. Introduction

Light environment is one important aspect of building indoor environment. Daylight design and analysis is one of the two parts of the indoor light environment. It is of great significant for realizing human comfort, zero energy cost, and subjective satisfaction in the field of building science and technology. Y-house is the design work for the competition of Solar Decathlon 2011, USA. It aims at realizing less energy consumption for a residential house by using solar energy as the only source of power supply. Daylight design and analysis for this house is stated in this paper.

Light environment is generally designed as the experience of designers or the favor of customers without scientific analysis for actual outcome and rational data. It is not reasonable to waste additional time and energy to rebuild the building because of the insufficient daylight inside. The lighting design depends on the light from windows to build light environment inside to satisfy with the users, so the designer can only visit the actual rooms to make out his plan after the indoor space design, especially the place of windows or partitions, is fixed in house.

Daylight simulation is based on the daylight design and analysis to work out the daylight factor or daylight illumination levels for the evaluation of architecture design and the interior lighting design at the platform of Autodesk Ecotect, which is the main analysis tool.

Under the simulation of software, designers can analyze the daylight distribution correctly and the arrangement of lights possibly. The modification for architecture design can be made before building and the suggestion can be given according to the result of simulation, if the daylight data does not meet the national standard or the real demand of designer and users.

The paper will detail the simulation processes in design strategy, analysis condition, and analysis and discussion, which are the main parts of all description contents. At last, the conclusion for daylight analysis will give the research value according to sufficiently analyzing the present data and point out the factual relationship.

#### 2. Design Strategy

Design strategy is made by analyzing of the architectural design, environment, location and other factors related to daylight. In this paper, the daylight simulation of Y-house selects the "autumn" pattern of passive solar equipment design (figure 4), since the competition will be held in October, 2011.

**Figure 2-1** shows the branches of Y house in are kitchen, bedroom, bathroom, living room, dinner centre, and equipment room .

Figure 2-2 shows the framework of Solar Container is depicted by designers in .

**Figure 2-3** shows Passive solar equipment design and is the combination of thin film modules and facade louvers and the panels would regulate the angles in 4 seasons if necessary.



Figure 2-1 Branches of Y House



Figure 2-2 Framework of Y House



Figure 2-3 passive solar equipment design

### 3. Analysis Conditions

According to the schedule of competition, the season is autumn, which the angles of the passive solar panels would be regulated.

Autodesk Ecotect, the software we use for daylight analysis, is an industry leading building analysis program that finally allows designers to work easily in 3D and apply all the tools necessary for an energy efficient and sustainable future. It features a designer-friendly 3D modeling interface fully integrated with a wide range of performance analysis and simulation functions.

**Figure 3-1** is the summary of analysis settings. The value of design sky illuminance is 7000lx, derived from the latitude of location. And the setting of sky luminance distribution model is CIE Over Sky Condition, which determines how available natural light is distributed over the sky doom. Window cleanliness in Ecotect, the likely cleanliness of Y house windows and the corresponding reduction in transmittance, is Average (x0.90).

**Figure 3-2** is the Analysis Grid for Y House, simply a grid of points used as the basis for spatial calculations in Ecotect. Number of Cells defines the number of individual cells in the grid over each of the major axis. The greater the number the greater the accuracy of the grid calculation, but the longer it will take.

The offset, equal to the working plane, is 750.0 mm, according to "GB/T 50033-2001 Standard for Daylighting Design of Buildings".

| Calculation <u>Type</u> : | Natural Light Levels - Da | wight Factors & Levels 💌 |  |
|---------------------------|---------------------------|--------------------------|--|
| General Settings:         | High Precision            | Average Window:          | Auto-rave model Euly compliant thermal model |
| <u>Sky Conditions:</u>    | CIE Overcast Sky 💌        | 7000 kes                 | Privated accuracy more                       |
| Calculate O <u>v</u> er:  | C POINT Objects           | Full 3D Grid Analysis    | Display test points                          |

Figure 3-1 the summary of analysis settings



Figure 3-2 the Analysis Grid for Y House

### 4. Analysis and Discussion

After the design is made, software simulation and results analysis have been done, in order to make sure the design outcome is fit to the strategy and comply with the related standards. Most natural lighting calculations are based on daylight factors. The Daylight Factor is simply a ratio of the daylight illuminance at a particular point within an enclosure to the simultaneous unobstructed outdoor illuminance, expressed as a percentage. Thus an unobstructed view of the sky would result in a 100% daylight factor. Daylight factors include the contribution of both internal and external reflections. Daylight Illumination Levels are simply estimated illumination levels calculated by multiplying the daylight factor (%) by the current Design Sky value (lx).

**Figure 4-1** shows the perspective daylight analysis of daylight factor. The difference of colors means the difference of factor values, as well as the height. Thus we can directly know the distribution of daylight from the 3D model.

**Figure 4-2** shows the plan for the daylight analysis of daylight factor. The connection of different colors in different rooms of Y House describes the variation of daylight factor.

**Figure 4-3** shows perspective for the daylight analysis of daylight levels. The values are simply calculated by multiplying the daylight factor (%) by the design sky value (7000lx in Washington D.C).

**Figure 4-4** shows the plan for the daylight analysis of daylight levels, which is similar with Figure 4-3.



Figure 4-1 Perspective for the daylight analysis of daylight factor



Figure 4-2 Plan for the daylight analysis of daylight factor



Figure 4-3 Perspective for the daylight analysis of daylight levels



Figure 4-4 Plan for the daylight analysis of daylight levels

**Table 4-1** is the calculation results of daylight for Y-house, the Minimum value of daylight factor  $C_{min}(\%)$  and Critical illuminance of interior daylight  $E_1(lx)$ , as the table 4-2 depicted in GB/T 50033-2001 Standard for daylighting design of buildings.

**Table 4-2** is standard of daylight design in China. According to 《Standard of daylighting design of buildings GB/T 5033-2001》, Standard value of daylight factor of residential building is stated to assess the result of Y-house.

Table 4.1 Value of David abt Faster of V House

| Table 4-1 value of Daylight Factor of 1 House |                   |                    |           |  |
|---|-------------------|--------------------|-----------|--|
| Daylight                                      | Boom              | Siding daylighting |           |  |
| level   | Köölli            | $C_{min}(\%)$      | $E_1(lx)$ |  |
|   | Bedroom           | 2.23               | 156.1     |  |
|   | Living Room       | 2.53               | 177.1     |  |
| IV  | Equipment<br>Room | 2.63               | 184.1     |  |
|   | Kitchen           | 4.50               | 315.0     |  |
| V   | Dining<br>Room    | 12.46              | 872.2     |  |
|   | Bathroom          | 2.20               | 154.0     |  |

 $C_{min}(\%)$ : Minimum value of daylight factor

 $E_1(lx)$ : Critical illuminance of interior daylight

|                | Building <sup>[9]</sup> |                    |            |
|----------------|-------------------------|--------------------|------------|
| Daylight Level | ROOM                    | Siding daylighting |            |
|                |                         | $C_{min}(\%)$      | $E_1$ (lx) |
| IV             | Living room             |                    |            |
|                | bedroom                 | 1                  | 50         |
|                | Study                   |                    |            |

|   | Bathroom    | 0.5 |    |
|---|-------------|-----|----|
| V | Stairwell   |     | 25 |
|   | Aisle       |     | 25 |
|   | Dining Room |     |    |

C<sub>min</sub>(%) :Minimum value of daylight factor

 $E_1$  (lx) : Critical illuminance of interior daylight

### Discussion:

- $C_{min} > 1\%$  and  $E_1 > 50$  lx in bedroom living room, equipment room and kitchen, all the rooms of level IV, which satisfy the GB in table 4-2.
- C<sub>min</sub> > 0.5% and E<sub>1</sub> > 25 lx in dining room and bathroom, all the rooms of level V, which satisfy the GB in table 4-2.

The most significant result that can be drawn from the data in figure 4-1 to 4-4 concerns the daylight inside house has comparatively uniform distribution according to the similar colors in the pictures. What's more, the daylight will be more sufficient between the wall and passive solar equipment panels, which is described by the color meaning high values. And from table 4-1 and 4-2 concerns all the factors meet the requirement of design strategy as well as related standard and codes for building daylight. So the daylight design for Y-house is good idea.

### 5. Conclusion

It is concluded that by software simulation and results analysis, the design result is proved to be good for application, and analysis process is necessary for architectural design. By a good daylight design, it is easy to create a comfortable light environment for room users.

The analysis of daylight is completed with the direction of detail knowledge under the autumn mode of passive solar equipment design, but the ones of another 3 modes, winter, spring, and summer, are not given in this paper. The limitation of the analysis is the surrounding of Y-house, which is supposed to be no high buildings and trees to affect the daylight of Y-house.

The simulation of daylight distribution is a fairly new method to evaluate the architecture design, especially the daylight design and the theory on this knowledge is published rarely with systematical discussion and study. It is through Autodesk Ecotect that the analysis of daylight is achieved quantitatively and intuitively, which displays the results of colorful pictures with color grade and accurate numbers.

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# Design Research in Cyber-Physical Systems through Weak-Bisimulation

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Bisimulation methods for design and verification of complex digital electronics have become well established in engineering practice. Concurrently, there have been dramatic theoretical advances in the theory of hybrid dynamical systems. This paper explores the how these advances can be incorporated into research methods for the emerging area of cyber-physical systems from a cybernetics perspective. The results can be used in determining how design of engineered systems can be safely integrated into physical systems.

### Index Terms—Bisimulation, cyber-physical systems.

### **1. INTRODUCTION**

There has been increasing deployment since the 1970's of digital communications and computer control of complex infrastructure systems. Examples include air traffic control, the operation of electric utility grids, ground transportation traffic management, biomedical monitoring systems, weapon systems (remotely operated drones, guided missiles), automated manufacturing and logistics support (supply chain management), banking and financial institutions, as well as in the operation of computer data networks in directing message traffic. The proliferation of safety and mission-critical computer controlled systems has motivated the emergence of cyber-physical (CP) systems as a new area of engineering research [1]. Cyber-physical systems are intrinsically hybrid dynamical in nature in that there is a coupling between the discrete-event and finite-state machine orientation of the cyber elements intermingled with the continuous-state nature of physical dynamics that are conventionally modeled by differential/difference equations. The challenges in designing and verifying the behavior of CP systems has been noted in terms of the intractable nature of attempting to model overall macro-level CP behavior based on explicit micro-level component simulations of detailed cyber and physical dynamics [2]- [4]. Thus, it is both challenging and an urgent priority to investigate design research in CP systems.

### 2. BISUMULATION OF DIGITAL SYSTEMS

A bisimulation is an abstraction in theoretical computer science. In a strict sense, a bisimulation is a relation between two state-transition systems such that state changes in one system are tracked in the other system, and vice-versa. This theoretical construct has yielded significant advances in verifying complex digital systems by determining a bisimulation between the complex detailed design whose states are grouped into broad categories and a simplified system for which tractable solutions exist regarding safestates, mode changes, state transitions, etc. Previous work has explored expanding the use of bisimulations to linear timeinvariant systems that switch between various specific parameters sets; i.e., switched linear systems [5]. Such cases are encountered for example in electric power systems when the electrical dynamics abruptly change as a consequence of an electrical fault that results in a circuit breaker opening and thereby de-energizing some portion of the network. To determine if such automatic response to fault conditions is achievable, methods as in [6] maybe employed in terms of reachability concepts from control systems theory. Ongoing research seeks further understanding for a wider class of dynamic systems, such as those with stochastic and nonlinear behavior [7]-[9].

#### **3. MOTIVATION FOR DESIGN ENGINEERING**

The emerging technology field of cyber physical (CP) systems brings to the forefront the needs for innovation in design engineering. In particular, often the cyber elements include software modules that have been well characterized and are reused in various portions of the system. Consequently, a meta-state can be defined that is the aggregate of a number of individual state transitions. By relaxing the state-to-state identification between the actual cyber system, then a weak-bisimulation is formed. This allows then coupling to the physical system for design research purposes at an abstraction level that preserves the important behavioral characteristics of the overall CP system without introducing the intractability of analysis that results when a full bisimulation is defined for the cyber components.

#### 4. CYBER-PHYSICAL SYSTEMS

Cyber-physical (CP) systems as a distinct science have evolved out of continuing advancements in the area of cybernetics, microelectronics, digital communication systems and sensor networks. This has occurred through the convergence of many technologies over the last few decades that has allowed for mobile electronic devices to be incorporated in previously inaccessible areas. Examples include material handling automation using RFID tags for inventory control, traffic controls based on vehicle-to-vehicle radio communications as well as roadside sensors, and implantable medical devices for the treatment and monitoring of hypertension and diabetes. Of particular interest for cybernetics related is the role of feedback between the cyber and physical subsystems. In general, the difficulty presented in the design engineering of CP systems is the complexity of understanding the possible number of interactions that may occur once a particular event transpires. As an example, the state of an electric utility grid is comprised of the voltages and currents flowing between generators and loads at a particular instant. Various circuit breakers and disconnects are positioned in such a manner that each of the transmission lines and transformers within the system are overloaded. Due to adverse weather conditions resulting in thunderstorms and high winds, a fault might be induced where a transmission line is broken and results in a short circuit to ground. This results in an abrupt electrical transient whose characteristics are dictated by the physics of the electrical circuit. Immediately after the fault condition, the electrical current then rapidly increases in the vicinity of the faulted transmission line. This fault condition is sensed by the protection circuitry, and automatically responds in a manner to isolate the fault condition by opening circuit breakers. Once the related circuit breakers activate, there is an ongoing re-closure sequence where the protection control circuits seek to reenergize the system to restore electrical service in the vicinity of the damaged transmission line. Each of these control functions related to switching the electrical system in response to the fault condition results in a physics-based electrical transient. However, the decision regarding what automatic protection function to initiate is cybernetic in nature. Each cyber-related interaction (e.g., opening a circuit breaker) involves the selection among many possible choices - that is, it is not known a priori which circuit breaker operation will achieve an optimal result in terms of both isolating the fault while also minimizing the service area that suffers from an interruption of electric power. In fact, for most of the electric power systems in operation throughout the world today there is such a large number of possible protection sequences that could be taken that it is a practical necessity that only the most rudimentary protection actions must suffice. Through a similar line of reasoning, the same type of dilemma is encountered in many other types of CP systems, such as air-traffic control, logistics planning, transportation networks, manufacturing operations, etc.

For CP systems, the complicating element of analysis involves the abrupt transition from one mode of operation to another. This can be formalized as shown in Fig. 2 where the state *i* is modeled by a set of differential equations  $F_i(x)$ . From the example involving the electric power system, this would be the conditions corresponding to the fault condition of the transmission line short-to-ground, but prior to any circuit breaker protection functions. Once the current increases to a maximum allowed level, a boundary or "edge" condition is reached corresponding to one of the electrical currents in the state space of  $F_i(x)$ . Once the current reaches the edge, then the associated "guard" function is triggered (a circuit breaker is opened) which results in a "jump transformation" in the electrical system to a new set of state equations  $F_j(x)$  and state condition *j* for the new power system configuration.



Fig. 1: State transition diagram.



Fig. 2: Switched trajectories during transition jump.

In Fig. 1 the concept of each state node is identified with a set of differential and algebraic equations for the set of conditions that the system is operating at that instant. In general, there are many possible guard conditions that might be defined, and a multiplicity of defined edges to account for the various conditions that would necessitate a transition to a new operating node. Each node point in the state-transition diagram of Fig. 1 itself has some set of dynamics in the time behavior of the system. This is shown in Fig. 2 to indicate how the states (three-dimensional state-space in this example) might evolve during the transition from one node to the next corresponding to Fig. 1.

In order to formulate a design engineering structure that addresses the challenges in dealing with Cp systems, we begin by noting the available computer aids that are currently available for modeling jump-transition systems. Fig. 3 shows a block diagram of a jump-transition system developed in Matlab-Simulink [11] using the StateFlow package. This give the design engineer a tool for simulation of complex systems - however it is noted that this does not provide guidance in the synthesis of CP systems. For developing a CP synthesis method we begin with an alternative approach – that is, instead of beginning with the details of physics-based models (differential equations), instead begin with the cyber description of transitions as a automata employing the design verification techniques that have been developed for complex digital systems such as microprocessors and VLSI microelectronic circuits. The techniques for verifying large scale digital electronic circuits are based on first verifying individual gate-level
logic functions. Once these gate-level functions have been verified, then they are re-used as part of more complex circuits. At the highest system level, the verification process only concerns itself with approximations of the system behavior. That is, it is not necessary to verify every possible gate-level transition, but rather to partition the automata into groups of states, and to examine only the transitions across the portioned states.

- F<sub>k</sub> (flow constraints), J<sub>e</sub> (jump mappings), and G<sub>ik</sub> (guards) are convex polyhedra
- F<sub>k</sub> are independent of x(t)



Fig. 3: Computer aided simulation model of CP system.

For designing a CP system, there is a set of criteria defined for proper operation of the system. These requirements can be listed and prioritized into a set of properties P<sub>i</sub> that correspond to the defined set of requirements. For the example of the electric power system, properties might include power flows being below that maximum rated value of a transmission line, and the operating voltage at service connections to customers. The difficulty in CP synthesis (verification) is that direct verification of the system by examining each possible transition as in Fig. 1 is prohibitive in terms of computational intensity, as well as not necessarily giving a definitive result even if one attempted to exhaustively consider ever possible transition. If a suitable approximation model M' of the original system M can be developed which captures the edges and guard properties, then this simplified model M' can be verified in a many that yields a direct synthesis approach for the designer. The simplified system M' is designed in terms of the properties P' which encompasses the behavior of the system in terms of its critical outcomes rather than a detailed (and hence obscure) minutia of the state-space description. The model correspondence that is used in relating M to M' is then used in defining the synthesis properties P to P' for then relating back to the design objectives of the original system. This relationship between the physics-based model M and synthesis properties P to the design model M' and synthesis properties P' is shown in Fig. 4.



Fig. 4: CP system model approximation.



Fig. 5: CP system design and synthesis.

For the process of developing CP systems, the structure of design synthesis is often tabulated as a set of properties to be achieved. Each property of the design then needs to be synthesized to ensure compliance. This is done on the model through a model checking program that propagates the set of states of M' instead of individual trajectories as in Fig. 1. The result of the model checking program is either a confirmation of the property, or a counter example showing that the property (design feature) fails through a counter-example. This structure of synthesis through defined properties P' to property verification is shown in Fig. 6.With this then the structure for CP system design within the context of Computer Aided Cyber System Design (CACSD) is shown in Fig. 6.



Fig. 6: Computer aided cyber system design.

#### **5. BISIMULATION METHODS**

The theory of simulation of timed-automata has been developed by a number of researchers [5]-[9]. To summarize,  $T_2$  is a simulation of the timed-automata  $T_1$  for the following definition:

 $\begin{array}{l} T_2 \mbox{ simulates } T_1 \mbox{ if } \\ \mbox{ there exists } \leq \ \in \ Q_1 \times Q_2, \mbox{ a binary relation such tha} \\ \ \cdot \mbox{ is total and onto (involves all of $Q_1$ and $Q_2$)} \\ \ \cdot \ Q_{1o} \leq Q_{2o} \\ \ \cdot \ q_1 \rightarrow_1 q_1' \mbox{ and } q_1 \prec q_2 \\ \ \Rightarrow \mbox{ there exists } q_2' \mbox{ such that } q_1' \prec q_2' \mbox{ and } q_2 \rightarrow_2 q_2 \end{array}$ 

A graphical representation showing the mapping of statetrajectories  $T_1$  and  $T_2$  between state  $Q_1$  and  $Q_2$  is shown in Fig. 7. It is emphasized that the simulation relationship is directional in that it is reflexive for  $T_2$  with respect to  $T_1$ .



Fig. 7: Simulation relationship.

Bisimulation has been formalized as a design tool for large scale digital systems. Bisimulation is defined in terms of a symmetric relationship:

 $\begin{array}{l} \text{Given } T_1 = (Q_1, \rightarrow_1, Q_{10}), \ T_2 = (Q_2, \rightarrow_2, Q_{20}) \ , \\ \text{a relation} \equiv \in Q_1 \times Q_2 \ \text{is a bisimulation if} \\ \bullet \equiv \text{is a simulation relation for } T_1, \ T_2 \\ \bullet \equiv^1 \text{ is a simulation relation for } T_2, \ T_1. \end{array}$ 

The symmetric relationship for bisimulation is shown in Fig. 8. This allows for conclusions to be drawn regarding the original physics-based system state  $Q_1$  based upon state-transitions  $T_1$  and  $T_2$  observed in the simulation state  $Q_2$ . Bisimulation is shown graphically in Fig. 9.



Fig. 8: Bisimulation relationship.

The bisimulation can then be integrated into the overall synthesis structure by modifying Fig. 6 to include the simulation system in place of the physics-based detail model. Once a bisimulation has been established for a CP system, then the original system can be portioned in order to establish the design synthesis properties. Formally, this is accomplished by creating a quotient transition system [9].



Fig. 9: CP system synthesis with bisimulation.

A quotient transition system is conceptually a portioning of the state space of the physics-based model into regions which would correspond to the edges for which a guard would initiate some specified jump transition in the CPsystem. The advantage of using a quotient transition system is that this provides a means for the designer to specify the desired behavior of the CP system (synthesis), rather than simply analyzing the behavior of a given system (analysis). Formally, a quotient transition system is defined by:



Graphically, the concept of using a quotient transition system to synthesize the CP-system is shown in Fig. 10 where the partitioning of the state trajectories T is shown in terms of the partitions of the quotient transition system T/P.



Fig. 10: Quotient transition system partitioning.

## 6. CONCLUSION

A technique for synthesizing cyber-physical systems is presented. In contrast to previous methods that aim to work directly in terms of physics-based models with supplemental functionality added on by the cyber elements, the proposed method uses theoretical results from the cyber related research world to adapt to the physics-based models. Using the analysis-synthesis tools given by bisimulation of complex digital systems, a framework for design engineering of CP systems is then derived where a quotient transition system is used to simplify the design process by partitioning the CP system based on the overall system design objectives.

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## Towards Ubiquitous Database Management Systems A Case Study of E-Government Services in Selected Developing Countries

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Abstract: Ubiquitous Computing (UC) is a paradigm shift in computing and computing devices embedded in everyday appliances in the environment cooperates to provide information and services on behalf of their users. With the initiation of UC research has grown in community involving anthropologists, computing scientist and social scientist, working towards the realization of the UC dream. As envisaged by Marc Weiser, UC on mobile devices is starting to become an important player in the industry and its application is becoming common place, in service delivery. Although research has grown the state of relationship between design and research in business systems is underinvestigated and little has been done. System design function is critical in system development for successful business systems. This paper investigates the relationship between research and design to give light on why it is critical. The paper aims to improve the illustrations on research and design factors and demonstrates the relationship by conducting a survey on countries which have successfully developed Ubiquitous Database Management System (UDMS) and applied best practices to develop UC in developing country settings to facilitate service delivery to users. The paper also claims that research views are shaped of what constitutes the value as created by design.

*Keywords:* Ubiquitous Computing, Ubiquitous Database, "unstated", customer-based, silicon-based, concrete forms, inconspicuous, UDMS.

## Introduction

With the advent of UC there has been a growing interest in the research community involving anthropologists, computing scientist and social scientist, working towards the realization of the ubiquitous computing dream [1] [2]. Rapid expansion of information and communication technology, mobile communication devices and the Internet plays a critical role in people's lives. The technology devices and applications support offer numerous communication platforms. Computer devices have been used for various tasks and support an effective systematic work.

Research is a major tool used for generating knowledge which, in turn, is applied to design in order to realize business systems. However, the current research is not binding to design in business system development. Research identifies a problem to solve in some way, by having a wider understanding of context of knowledge in which that problem is set. Research takes responsibility of project conclusion. Research results into a contribution of a shared knowledge from reviewed document. The purpose is to find out how the idea of "unstated" contributions to knowledge or understanding might be worked out and made useful. Research on consumer responses elicited by business model design is in early stages, but limitedly constitute to the antecedents of communication behavior.

Design is necessary for expanding research into business related fields. Design impact on several businesses related concepts, communication methods, and quality of service, limited observed evidence is presented. While the importance of design is well documented particularly in design literature, experiential research on the impact of design is quite scarce in the marketing field. Design impact on the formation of brand knowledge is limited in study.

In respect to the above statements, to create the right environment for system development that is inclusive, as steps in system development process. There are not many existing references for evaluating effective system development that recognizes the significance the relationship. To overcome this limitation, the study examines this issue to improve the process and outcome of system development. The research is based on integrated systems that satisfy those served by it.

This paper presents a report conducted in countries which have successfully developed ubiquitous database management system so as to develop the same in developing countries settings for the purpose of facilitating service delivery to citizen. The paper claims that research views are shaped of what constitutes the value as created by design.

The remainder of the paper is structured as follows: Section 2 describes related works. Section 3 focuses on design of the research to be conducted. Section 4 focuses on case studies and gap analysis. Section focuses on the steps of the proposed solution. Section 6 focuses on recommendations and conclusions.

## 2. Related work

The role of design in business system is a professional service of creating and developing concepts and specifications to optimize the function, value and appearance of systems. However, currently the design activity is as an involving compromise, choice, creativity and complexity in the new system development process. The role of design is not commonly delineated in representations of system development process. However, for the purposes of customer-based businesses paradigms, an understanding of customers and new market trends is driving the need to relate design to research before developing a new system.

## 2.1 Relationship between research and design

Design should be recognized to support organization system development. Design corrects misinterpreted information in the cooperation process that may contain unclear and superfluous information [16]. The role of design has been shifting by considering the complexity of the current systems that requires thorough presentation to reduce uncertainties associated with long delays, high costs, and insufficient attention. In addition, organizations are exploring means to solve the problem of unclear relationships to avoid consequences like financial losses, wasted time, and failed projects.

The value of design is well recognized and considered as a factor in economic theory. Design is a fundamental professional competence and that every design is aimed at changing existing situations into a better one. Design is a thought-process that underpins all kinds of professional activities. Designers use design to develop ideas and the ideas developed are used to record the designers' concepts and the formation of the concepts.

The designs become the aids for the progression of a problem solution and play an essential part in knowledge acquisition and representation. The ability to read or produce designs appears to be ideal to develop the gathered architectural expertise. Design is a means to an end a tool to help solve problems, create new ideas and assist communications (15). It is the easiest and most widely used direct mean to highlight the research work. Designs cover design solutions and are critical for identifying the conflicts and possibilities. It is a dialogue between the designer and what the designs suggest.

Most architects use concrete forms to help them develop ideas. Designers approach problems by creating a tentative solution, prior to understanding the problem. He proposes that the environment provided by the object to be created is an integral part of the designer's thinking process and the location for the complex ideation [2]. A valid research contribution to knowledge may not be precisely disseminated by the researcher without designing it.

## 2.2 Ubiquitous Computing and Database System

Ubiquitous Computing is a new frontier in the world of computing conceived in 1991 by Marc Weiser and his colleagues at Xerox PARC; having observed that siliconbased information technology was far detached from the environment. In his seminal paper [10], Marc Weiser argued that the idea of a "personal" computer is misplaced, and that the vision of laptop machines, dynabooks and "knowledge navigators" is only a transitional step toward achieving the real potential of information technology. To Marc such machines were operating in their own world and cannot truly make computing an integral, invisible part of the way people live their lives. Marc Weiser also notes in [10] that "The most profound of technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it." Weiser thus put forward a vision of future computer systems where "Computers themselves vanished into the background" and thus becomes inconspicuous. The vision initiated Ubiquitous Computing.

UC is thus a paradigm shift in computing where computing devices embedded inconspicuously in everyday appliances in the environment cooperate to provide information and services on behalf of their users. UC is thus a "calm technology" residing in an environment where the computing devices are context aware, and proactively provide services to and on behalf of their users [11]. These devices, as described by Weiser, "are invisible and come in different sizes, inch-scale machines, foot-scale machines and yard-scale displays [10]". Among other characteristics, ubiquitous computing is thus said to be computing anywhere, and anytime, as well as computing without conscious effort, computing with a sense of super-realism and computing that is context-aware, with the user's point of view central to the computing process. Ubiquitous Database is a kind of Ubiquitous Computing that places data everywhere [16] [7]. [6] are of the view that Ubiquitous Computing, particularly UDMS, enables us to have access to real world information from sources that hitherto were impossible to get, and to control various everyday objects that hitherto could not be controlled, by embedding computing devices in them [4].

[3], notes physical integration and spontaneous interoperation as the two main characteristics of UDMS, arguing that much of the vision, as expounded by Mark Weiser and others, either deals directly with or is predicated on them. [13], introduced a new concept, "convenience", as a characteristic of UC technology, even though it has not gained currency in the literature. They present convenience as a multidimensional construct and proposed a conceptual framework for assessing the convenience of services, drawing on [1], who argues that "the concept of convenience has includes time, place, acquisition, use and execution".

## 3. Research design

## 3.1 Statement of Problem

The realization of the Marc Weiser's dream of Ubiquitous Computing is an on-going research problem in research labs across the world. The view that ubiquitous computing will enable us to have access to real world information from sources that were impossible to access, and to control daily objects that we could not control, is a view that we subscribe. The problems to address include:

- Focus on users instead of agencies in service provision
- Facilitate inclusion of marginalized society.
- Set up contact point integrated system for users
- Access to services, anytime, anyplace
- 3.2 Objective and Scope of the Study
- Review globally benchmarked integrated systems
- Delineate best practices in developing integrated systems in developing countries
- Develop an integrated assessment framework and a ubiquitous database architecture

• Perform e-readiness analysis for integrated systems in Ethiopia, Ghana and Kenya

## 3.3 Methodology and Approach

The research is conducted by:

- Underrate a desktop research on UC and Databases.
- Review cases of success stories and adopt best practices from Canada, Taiwan and South Korea to develop Readiness Assessment Framework (RAF).
- Carry out gap analysis, based RAF established.
- Developed ubiquitous database architecture

## 4.0 Case Studies and Gap Analysis

## 4.1 Introduction

The creation of user centered communication platform is a necessary condition for strategically positioning a country to meet squarely the emerging new paradigm that will supposedly change the practices of enterprises and the way they will deliver services in the 21st century. A user centered communication platform will not only play a key role in expanding national competitiveness, but will also empower the user in terms of their interaction with business enterprises, such as access to services and information.

In order to meet users and private business needs, user centered communication initiative is critical for transparency and effectiveness. The platform will expand user and private enterprises use of Information Technology.

Enterprises worldwide are preparing for the arrival of the emerging user centered communication paradigm. For instance, the US passed user centered Act in 2000, England created "UK Online" and Singapore implemented an e-Citizen initiative. Beyond establishing computing systems and infrastructure in enterprises to support services, developing world enterprises are setting strategic goals to overhaul business process and to change the mindset of employees, as well as citizenry, about enterprises.

In a similar vein Korea and Canada, having built two of the most advanced information networks in the world, embarked upon and completed two of the most successful citizen centered initiatives in the world. As a result Korea and Canada, instituted successful user centered initiatives, are striving to make services convenient and accessible, through business process re-engineering and the use of IT.

These success stories are testimonies to the assertion that the establishment of a successful user centered communication platform impacts positively on a nations competitiveness as it eliminates bureaucracy, and improves the overall efficiency of the enterprises. Thus, it goes without saying that developing user centered communication plan is no longer an option for enterprises, but necessary steps they must take.

The next section examines the user centered communication. Canada and South Korea identified initiatives with the objective of identifying critical factors for their success and based on that develop a framework for assessing the readiness of developing countries for creating user centered communication platforms.

The Initiatives of Canada and South Korea with the objective of identifying the factors that were critical to the success of their initiatives and based on that develop a framework for assessing the readiness of developing countries to create user centered communication platforms.

## 4.4 Case Studies - Frontiers of Ubiquitous Computing

For 30 years, the power of microprocessors increased and the increase applies to some other technological parameters like storage capacity and communications bandwidth. The trend means that computers will become considerably smaller, cheaper, and more abundant, hence become ubiquitous. They are also finding their way into everyday objects, resulting in the creation of "smart" things capable of accessing the Internet and its varied resources to optimize the purpose, and cooperate with each other.

Ubiquitous computing paradigm foresees seamless integration of communicating and computational devices and applications (e.g., smart sensors, wireless networks and mobile agents) embedded in all parts of our environment, from our physical selves, to our homes, our offices, our streets and so forth. However, the benefits will only be realized if security issues are appropriately addressed.

UC means new devices, sensors, and protocols throughout society, and thus new sources of consumer data. The new data sources, along with new means of individual identification, constitute a personal privacy concern: what should and should not be done with personal data..

Three knowledge visualization techniques namely: factor analysis, pathfinder networks and context-based ontology are UC related [5]. The comparison of the techniques showed that application of ubiquitous computing in health care is the most popular research and PFNet provide a broader view UC [16].

## 4.4.1 Case 1: Korea – Reducing the digital divide

A study conducted by a researcher in Korea recognized that there is a big gap between developed and developing countries in regard to UC. As such it is believed that developing countries can learn from the developed countries so as to reduce the digital gap as Korean did. The Korean government reduced the digital gap by updating, adding and enhancing a toolkit to support the developing countries [9]. The methods of implementing this were identified based on personnel experiences and knowledge. A SWOT analysis was conducted, followed by the implementation of management development processes, and then monitoring and evaluation process which was focused on users. Korea republic adopted a centralized development strategy which has become their foundation for economic development.

**4.4.1 Case 2:** Japan - Ubiquitous Computing for Commerce Japan initiated digital money payment systems that use Sony's FeliCa near-field communication smartcard technology [8]. The approach incorporates heavy dependence on IT-based Japanese reluctance to make credit card payments over the Internet or via telephones opened the way for Japanese convenience stores to provide third-party payment services, which required substantial IT infrastructure. They followed a alliances, a range of services and products, and telematics rather than PCs.

# **4.4.2 Case 3:** Taiwan - Ubiquitous Mobile Database for Java Phones

This is a Taiwan case focusing on designing of a ubiquitous interface agent based on the ontology technology and interaction diagram with the backend information agent system [12]. Taiwan investigated ubiquitous interface agent with the Bluetooth wireless technique and related interaction diagrams under cloud computing environments. The system parts included the ubiquitous interface agent as the client device; the Bluetooth wireless technique as a connecting technology; and the backend information agent system

| Criteria/ Parameter                    | Components Metrics   | Canada       | Korea         | Ethiopia    | Ghana       | Kenya    |
|--|--|--------------|---------------|-------------|-------------|----------|
| Level of Bureaucracy                   | Single/Integrated Point of Contact   | Low          | Avg           | High        | High        | High     |
| Governance and Leadership<br>Readiness | Policy framework<br>Business contingency<br>Service Managers   | High         | High          | Low         | Low         | Low      |
| User Readiness                         | Accessibility<br>Social<br>Culture, language, Literacy<br>Disability<br>Economic<br>Digital divide<br>Limited public Access            | High         | High          | Low         | Low         | Low      |
| Trust Concerns                         | Privacy and Security<br>Confidentiality<br>Privacy<br>Authentication<br>PKI  | High         | High          | Low         | Low         | Low      |
| Competency Readiness                   | Qualified Personnel<br>Permanent/Outsourced<br>Contract Negotiation Skills<br>Relationship Management<br>Contract Admin Skills         | High         | High          | Low-<br>Avg | Low-<br>Avg | Low –Avg |
| Technology Readiness                   | Hardware<br>System/Application S/W<br>Communication/Network Infrastructure<br>Internet Penetration<br>Legacy Systems                   | High         | High          | Low         | Low         | Low      |
|  | Availability of Prof. Skills<br>Web Tech & Portal Design<br>PKI  | Avg-<br>High | Avg –<br>High | Low-<br>Avg | Low-<br>Avg | Low-Avg  |
| Legal Readiness                        | Electronic Business Transaction Law<br>Right of access to information Bill<br>Electronic Payments Law<br>Legality of notification, Mgt | Avg          | Avg           | Low         | Low         | Low      |
| Codes & Standards                      | Harmonized Codes and Standards   | High         | High          | Low         | Low         | Low      |

Table 1. Comparison of E-readiness

providing cloud computing. This environment is suitable for cloud computing for extensively and seamlessly entering related web information agent systems through modern mobile equipment.

## 4.5 Comparison of E-readiness index

The E-Readiness Index is a composite index derived from component readiness indices like infrastructure index, mobile phone subscription index, and human resource competence index. As illustrated in the Table 1 there is a direct relationship between the E-readiness and the infrastructure index; and the mobile phone subscription. The comparatively very good infrastructure of South Korea with

high level customer connectivity is reflected in the high E-Readiness index. Thus it takes good infrastructure and equipping users with the terminals to access the platform for service delivery.

Table 1 illustrates an E-Readiness Framework developed to assess the E-readiness of selected developing countries namely: Kenya, Ethiopia and Kenya, using Canada and South Korea as benchmarks. As indicated, whilst the level of bureaucracy of Ethiopia, Ghana and Kenya are high compared to those of Canada and South Korea, their government and leadership readiness, customer readiness, trust concerns, competency readiness, technology readiness, legal readiness and codes and standards are low.

The countries have to improve the IT skills and competency of service personnel as well citizens and business clients to effective service delivery. They have to improve the IT skills and competency of the service, personnel, and citizens for business clients to run effective service delivery. Moreover, the public services of these countries need to reform organization structure and conduct business process re-engineering to minimize the high bureaucracy and red-tapism in their civil services.

## 5.0 Steps in the Proposed Solution

There is globalization and trends in the market. No country can escape the effect of these trends, considering that the natural resources are also scarce and the countries must develop nationally. A responsible nation should be able to protect the peoples' lives by implementing UC by creating governance whereby markets and society cooperate with the government to solve social problems. In addition, stakeholders must be made to understand the concepts, goals, requirements, limits, contents of UC. The concepts meaning of change corresponds to Information Technology (IT) development and the innovation done by government.

## 5.1 Stages of UC Action Plan

UC lowers delivery costs in worldwide groups by enhancing communication and allowing interactions. However, the decrease is constrained by infrastructure cost and individual behaviors, activities and interaction practices.

UC is a set of related parts making the entire system [9]. Resources of all kinds flow across the system parts inform of input, throughput, output, and feedback. The entire system is accessible to the outside environment. UC is to achieve seamless integration between systems and the implementation covers research, design, development and deployment as shown in Table 2.

| Table 2: Stages | of UC | Action | Plan |
|-----------------|-------|--------|------|
|-----------------|-------|--------|------|

| Steres      | Duilding Pleaks    | Actions                                |  |  |  |
|-------------|--------------------|--|--|--|--|
| Stages      | Dulluing Diocks    | Actions                                |  |  |  |
| Research    | Team, awareness    | 1. Define mission and goals. 2.        |  |  |  |
|             |                    | Identify benchmarking countries. 3.    |  |  |  |
|             |                    | Determine network policies. 4.         |  |  |  |
|             |                    | Develop social awareness. 5. Form      |  |  |  |
|             |                    | political leadership                   |  |  |  |
|             | Form agencies      | 1. Create agencies. 2. Identify        |  |  |  |
|             | -                  | partners: committees, leadership       |  |  |  |
|             | Explore            | 1. Natural and human gaps. 2.          |  |  |  |
|             | environment        | Political and administrative barriers. |  |  |  |
|             |                    | 3 Communication and network gaps       |  |  |  |
|             | Referencing        | 1 Past successful cases 2 Successful   |  |  |  |
|             | Referencency       | countries                              |  |  |  |
| Design and  | Vision and         | 1 Define mission and vision            |  |  |  |
| Design and  | wision and         | 1. Define mission and vision           |  |  |  |
| development | D                  | statements. 2. Strategize targets      |  |  |  |
|             | Develop            | 1. Develop administrative              |  |  |  |
|             | framework          | framework. 2. Rank the targets. 3.     |  |  |  |
|             |                    | Create targets units                   |  |  |  |
|             | Develop strategy   | 1. Conduct major reforms. 2.           |  |  |  |
|             |                    | Empower the people. 3. Define users    |  |  |  |
|             | Administer         | 1. Human, financial, and               |  |  |  |
|             | significant issues | technological resources. 2. Develop    |  |  |  |
|             | •                  | policy and regulations. Understand     |  |  |  |
|             |                    | stakeholders. 3. Determine             |  |  |  |
|             |                    | management methods                     |  |  |  |
|             | Develop the        | 1 Identify ISP 2 Reengineer            |  |  |  |
|             | system             | husiness processes 3 Develop the       |  |  |  |
|             | system             | system                                 |  |  |  |
| Doploymont  | Evaluata the       | Monitor and evaluate the system        |  |  |  |
| Deployment  |                    | Wollitor and evaluate the system       |  |  |  |
|             | system             |  |  |  |  |
|             | Operate the        | Operate, maintain and manage           |  |  |  |
|             | system             | information resources                  |  |  |  |
|             | Get feedback       | 1. Determine public relation to        |  |  |  |
|             |                    | system use. 2. Get users feedback. 3.  |  |  |  |
|             |                    | Implement feedback to enhance the      |  |  |  |
|             |                    | system                                 |  |  |  |

## 5.2 Organizational Structure & Business Process Re-Engineering

It is recommended to the various countries to first and foremost conduct organizational restructuring of service delivery. This will bring change in business processes, and make the service amenable to the diffusion of information technology into the service. It will reduce the work flow chain and consequently reduce the level of bureaucracy. This is by creating a single service contact point.



Figure 1 illustrates a typical framework of service delivery before developing integrated proposed framework for service delivery for Ethiopia, Ghana and Kenya. The existing frame has several access points to service delivery. This results in a redundant database content and breeds inefficiency and high bureaucracy in accessing services. In the proposed framework, a user or business entity will only need to access one integrated contact point to access any kind of service. This reduces work flow chain and trips to transaction. It harmonizes codes and standards, systems and application software and database of users' service.

### 5.2 Technological – Ubiquitous Database Architecture



The Ubiquitous Database Architecture is based on the Client Server Concept. Apart from organizational restructuring the database for integrated services need to be redesigned to accommodate the needs of the emerging paradigm of ubiquitous computing and ubiquitous database management system. The following database architecture and design shown in Figure 2 is recommended for the development of Ubiquitous E-Healthcare as Ubiquitous Computing service for Ethiopia, Ghana and Kenya client server concept. It has a client side hosted on a smartcard, and a server hosted on a desktop. In view of the limited resources, processor and memory of the smartcard, is very difficult to implement the full functionality of a rich DBMS on it. The function of DBMS is therefore divided into a host PC and on the smart card.

The part on the host is a preprocessor that transforms a query language into primitive commands. In addition, it takes charge of the management of schema based view and transaction roll-backing. On the other hand, the part on the smart card is a command processor that executes primitive commands that create, read, write and delete data objects. Executions are controlled and both parts are connected through an encrypted Internet communication.

Relational database design model is recommended. Listed is the entity relationship design for the proposed E-Healthcare system, capturing the schema for patients and health facilities (hospitals and clinics), diseases, etc as shown in Figure 3.



Figure 3. Database Design

## 6.0 Recommendation and Conclusion

Based on the gap analysis following are suggested:

1. Level of Bureaucracy: To improve business process it is necessary to focus on reducing bureaucracy level by creating a Single/Integrated Point of Contact for customers.

2. Technology Readiness of Ethiopia, Ghana and Kenya are very low compared to the benchmarked countries. Effort is to invest in hardware, system software, communication & network infrastructure to facilitate service delivery.

3. Skilled Professional Manpower: Avail skilled professional in area of Web Tech, Portal Design and PKI. It is important to provide a variety of types of technologies to facilitate the implementation of e-government

3. Prepare users ready by changing cultural concerns like culture language, economic status and literacy barriers.

3. The government to prepare laws for accessing transactions **Conclusion** 

- UC and UDMS redefine the key aspects of user relationships
- Businesses focus on user needs and provide reflective services
- UC enhances social action innovative, novel organizational and new business models
- For security authentication to information is a must
- Develop systems which are context aware and location specific.
- Develop laws for cyber G2C and G2B transactions
- Gather ideas and designs to capture and store
- Focus is on cultural concerns in technology development to sustain the society

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#### Subtraction - the improvement of communication through critical aspects

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#### ABSTRACT

The research study, this article is based on, aims to develop principles to enable the transfer of research knowledge to teaching. In this article are presented the design and implementations of a research intended to support teachers in project understanding their practice and improve it. Furthermore, the central idea was to improve the communication in mathematics between teachers and teachers-students. Issues that arose from practice were framed in terms of learning. In addition, the variation theory formed the background to our work. The students' tests, examination of students' mathematical work, the teachers' lessons plan and reports of the lessons' instructions are the data base for this article. The analysis indicated that teachers were not able to describe the critical aspects in students' learning in the beginning of the project. By giving teachers the training that allows them to become reflective teachers, they also get the possibility, as professional decision makers, to develop the ability to identify the critical aspects in students' learning and consider how opportunities for learning can be enhanced. Furthermore, if the teachers base their instructions on the identified critical aspects and open up dimensions of variation in these aspects, the students' learning seems to be facilitated. The findings suggest that developing an understanding of the students' critical aspects can be a productive basis in helping teachers to make a fundamental change in their instructions and to improve the mathematical communication in the classroom.

**Keywords:** Mathematics, potential aspects, critical aspects, variation theory, effective communication, reflective teacher

#### **1. INTRODUCTION**

Integrating new knowledge created through research with teaching has become an important area that needs quick attention with the growing emphasis on student learning activities. There are few research studies that report the changes or transformation in teachers' way to teach mathematics. In recent years, a number of international studies [e.g. 2, 9] have shown that the process to integrate research with educational practice is slow. Several attempts to enable teachers to change their instruction have often been unsuccessful or are minor and inconsequential [e.g. 1]. Great deals of previous research [e.g. 2] speculate that fundamental change in teaching practice may be initiated by changes in teachers' knowledge. The main question is what kinds of knowledge would be changed.

Pang and Marton (2003) introduced the idea of the learning study. Learning study brings together a group of teachers who agrees to investigate a lesson very detailed. They first plan the lesson, observe it being taught in the classroom, discuss and modify the lesson when necessary. A learning study is theoretically grounded. Lo Mun Ling's (2009) paper outlines three applications of variation theory to learning in the context of learning studies: students understanding of the object of learning (V1), teachers' understanding of the same object (V2) and variation as a pedagogical tool (V3). Learning studies are presented as a harmonious process in which teachers manage, on the basis of their observations, to reach a consensual decision about how the lesson needs to be modified for the next cycle.

Our experience (discussions with teachers and principals in the beginning of the project) is that the teaching and learning process (in a learning studies cycle) is difficult to sustain in a longer term. We found a tendency for the process to return into a traditional form of the daily accountability pressures teachers' face in their work. One major theme in our project is to give teachers the possibility to use the scientific knowledge and research in their practice thus giving them the training that allows them to become reflective teachers and create an effective communication in the classroom. To make easy this process for the teacher we have designed a more flexible procedure for a learning study which better corresponds to the organisational conditions in Swedish school and can be applied in a longer term.

#### 2. THEORETICAL ASSUMPTIONS

On the basis of the article's aims, we will mainly focus on one major theoretical development concerned, namely the variation theory [4, 5], which relates the students' comprehension of a specific content to the experience of the pedagogical situation in which it is met with. Runesson (2006) specifies that variation theory "is not a theory of the mechanisms of learning but a theory of the relation between the object of learning and the learner" (p.406). The object of learning is broadly regarded as "the complex of different ways of experiencing the phenomenon to be learned about" [5, p.162]. The objects of learning are the final points toward learning activities are directed and how learners understand them. Variation theory focuses on the way in which a phenomenon is made visible in a teaching context. The main idea is that in order to discern a difference, we must have experienced a variation from our previous experience. Marton et al. (2004) have defined four patterns of variations which can facilitate students' discernment of critical aspects of the object of learning: (1) Contrast means that "in order to experience something, a person must experience something else to compare it with" (p.16); (2) Generalisation is to experience varying appearance of an object; (3) Separation of an aspect from other aspects is required; (4) Fusion is where several critical aspects need to be considered together.

To learn means to experience variations while to experience means to be aware of discerning certain aspects in a given context and relate them to this context. Moreover, only experiencing variation, which is a decisive condition for learning, can evoke discernment of these aspects. However, not all the aspects are significant for learning. A critical aspect of the object of learning contributes to a particular meaning in the learner's awareness. Only variation in the critical aspects is an essential condition for learning [e.g. 6]. To help students learn such topics teachers must be able to understand why students may experience difficulties in discerning their critical features or aspects. In the teaching context the teacher develops the teaching material with a perception of the content, that is, an "intended object of learning". Marton et al. (2004) argue that the object of learning is defined by "its critical features, that is, the features that must be discerned in order to constitute the meaning aimed for" (p.22). A critical feature is a way of "distinguishing one way of thinking from another" (p.24). The teacher can use appropriate variations within the identified space of learning to enact the object of learning [5]. What teachers/students learn constitutes the lived object of learning.

The concept of critical aspects develops in this article by introducing the division of the critical aspects into *potential and real critical aspects*. Potential critical aspects are what teachers believe to be critical aspects of students' learning, while real critical aspects are what student's exhibit as critical aspects in their learning. Those parts of critical aspects generate the relationship between the intended and the lived objects of learning.

We find it useful to distinguish between two broad categories of aspects because these facilitate to define what means by reflective teachers. *Reflective teachers* seek to prove beneath the appearance of a commonsense reading of experience potential critical aspects in their teaching. They investigate the real critical aspects and become aware to improve students learning.

The variation in the ways teachers/students experience the object of learning they meet in their area of activity can be analysed and described in terms of a small number of different categories determined qualitatively. Among these categories, teachers can identify the features that are important for current understanding, possibly not as comprehensive as the teacher's own understanding but adequately powerful for the current concerns. By being able to open up dimensions of variation in the context of the categories, the teacher is also able to identify ways of continuing to a more sophisticated understanding and to ensure that current understanding also contains the germs of even more powerful ways of understanding for future needs.

The concept of variation is not "an eclectic approach" or "diverse" organization, for example sometimes to work practically or thematically, you either let students work in groups or individually. It means different ways to vary the content - the different variation patterns: contrast, generalisation, separation and fusion.

We defined the *effective communication* as a process by which the teacher assigns and conveys meaning in an attempt to create shared understanding, i.e. the process of meaningful interaction among the intended, enacted, and lived objects of learning. In analysing the effectiveness of communication, endeavours to assess how the intended, enacted, and lived objects of learning compare, that can be discerned. The intended object of learning can be compared to the categories of description relevant to the phenomenon in order to determine both the level of awareness being focused on and the appropriateness of the intended object of learning. This could be considered an initial assessment of whether the teaching is intended to target the appropriate level of learning. The intended and enacted objects of learning can be compared to determine whether what is being taught matches to what was intended to be taught. The students' lived object of learning can be compared against categories of description as a means of assessing the level of learning achieved or against the enacted level of learning to determine whether the enacted object of learning is being transferred to the lived object of learning as expected.

#### **3. METHOD**

From 2007 to 2010, we studied the teaching and learning of the number sense, counting, pre-algebra, equations, formulae, functions and transformation of algebraic expressions from pre- to upper secondary school. Over a 3-year period the teachers participated in a development project (Critical aspects as basis for development of mathematics teaching and students' learning) that focused on helping teachers to identify the critical aspects in students learning and decided how to use that knowledge to make dimensions of variation in these aspects to improve the students' learning. This 3year study investigated 22 teachers' instructions as they learned. The research was working in collaboration with the class teacher. The teacher agreed to participate in the study reported in this article with the understanding that feedback was given to the school about the student's understandings of mathematical concepts thus these information's could be used to plan future teaching approaches.

An overview of the qualitative approach to data source, collection and analysis, the theoretical perspectives, and reliability can be seen in Figure 1.

| Data<br>sources | Data collection<br>techniques                            | Data analysis                                    | Reliability   |  |  |
|-----------------|--|--|---|--|--|
|                 | teachers description<br>of potential critical<br>aspects | construct potential critical<br>aspects profiles | Scoring of potential  |  |  |
|                 | interviews   | construct potential critical<br>aspects profiles | critical aspects  |  |  |
| teacher         | teachers' lessons plan                                   | identifying the object of<br>learning            | verification of the object<br>of learning with the plan<br>of the lessons |  |  |
|                 | teachers' report   | identifying patterns of<br>variation             | verification of the<br>dimensions of variation<br>with lesson reports     |  |  |
| atudanta        | students' tests  | ents' tests identifying real critical aspects ve |   |  |  |
| students        | interviews   | identifying real critical aspects                | critical aspects  |  |  |

#### Figure 1. Overview of the study approach

The analyses of teachers' description of potential critical aspects have been divided into distinct categories based on the aspects they focus on. The scoring of these aspects was carried out by comparing the number of sentences in each category with the total number of sentences that teachers took up. If there were confusions about certain expressions, group interviews with the teachers, they were carried out. The collection and analysis of data consist of three phases. The relations between those are shown in Figure 2.

The project began by explaining various concepts used in the variation theory to the teachers and putting those concepts into practice. Then the teachers worked to identify potential critical aspects in students' learning. Subsequently tests and interviews were conducted with students to identify the real critical aspects of their learning. The material was analyzed and differences between potential and actual critical aspects were identified (Phase 1). In the second phase, each teacher had to plan and implement 6 lessons focusing on the real critical aspects identified in phase 1. After each

lesson, a detailed report was made after the following template: (I) General information: school, class/group, teacher, moment, object of learning, type of lesson; (II) General purpose; (III) Specific purpose: content, emotional view, psychomotor view; (IV) Prerequisites: technical aids, materials; (V) Teaching method; (VI) Activities with students; (VII) Lesson implementation according to the following: didactic moments, teacher's activity, student's activity. The implementation of lessons ended with assessing students' learning using tests or interviews. The analysis of the collected materials focused on the identification of the critical aspects of the teachers, opening up the dimensions of variation and classifying them.



#### Figure 2. Overview of phases

There were 6 lessons based on the results of Phase 2. Teachers planned the implementation of the lessons and after each lesson they made a detailed report using the same template as in Phase 2. Teachers create the report to communicate their instructional activities regarding specific subject-matter and describing the variations opened in the identified critical aspects. Almost all reports developed by teachers contain information of students learning. The analysis of teachers' reports was conducted in the same manner as in Phase 2. This article will present only the analysis of phase 1 and 2 when subtraction is presented in the classroom. The material gathered in phase 3 is in the process of being analysed.

Parents of all students were informed about the research and their right to withdraw their child from participation in the research at any time. No parent chose to withdraw a child from this research. Students were also informed in simple terms about the reasons for the researcher's presence in the classroom and for interviews, and were given the choice of whether they wanted to participate or not.

#### 4. RESULTS

On way to demonstrate the interaction between the potential/critical aspects, reflective teacher and effective communication is to point out what happens with a learning object (subtraction) for 4 primary grade teachers (grade 1, 2, 3 and 4).

#### Phase 1

By analysing the teachers' reports and students' tests, 5 distinct categories could be identified: the whole (A), the parts that form the whole (B), the relation between the parts (C), the transformation between the parts (D) and the relation parts-whole (E). The teachers' written reports were completed by group interviews when unclear expressions were encountered. The results are presented in Figure 3.



Figure 3. The potential and real critical aspects

In Figure 3 we can see that there is a difference between the potential and the real critical aspects. To a large extent teachers believe that students do not understand a task that contains subtraction as a whole (A), the numbers constituting parts (B) and the parts related to each other by subtraction (C). However, they do not believe that students need a better understanding of how to relate the parts to each other in a different way, i.e. the transformation between the parts (D) and the relation between parts and the whole (E). Despite this, the result in Figure 2 shows that about 50% of students do not understand the first three relationships and more than 50% of the students do not understand the last two relationships.

The results of students' understanding of subtraction are worrying. The following extract from interviews shows that first year students do not discern the relation between parts and the way in which the parts constitute the whole:

> Teacher: Look here now then. I have 1, 2, 3, 4, 5, 6 crayons in my hand. Now I put 2 crayons in the box. How many do I have left in my hand? (The teacher holds his hand behind his back.) Student: 4 Teacher: How do we say this in math language? Student: 2-4 = 6 Teacher: Oh, do you know what are you saying now? If we have two crayons, we can hide the fourth in the box. Is it possible?

Student: No Teacher: No that was not what happened. Teacher: How many crayons did I have in my hand? Student: 6 Teacher: How do we write? Student: 4-2 = 6

This phenomenon persists in the year 2, 3 and 4, being the basis for the children understanding that the larger number comes first when writing subtraction. Students who are finding subtraction difficult often make that particular error. They aren't well grounded in the concept that the larger number is written first – a dilemma which can create problems turning into a mystery for them. That can be seen in the following example:

Malin saves money to buy a bike that costs 525 Swedish Kronor. She has 378 Swedish Kronor. How many more does she need before she can buy the bike?

| 5 | 0 | 0 | - | 3          | 0 | 0 | 2 | Ż | 0 | σ  |     |  |
|---|---|---|---|------------|---|---|---|---|---|----|-----|--|
|   |   | • |   |            | - |   |   |   |   |    |     |  |
| 7 | δ | - | 2 | 0          | 5 | 5 | 0 |   |   |    |     |  |
| 1 |   |   |   | $\sim_{1}$ |   |   |   |   |   |    |     |  |
| 8 | - | 5 | 2 | 3          | : | 2 | 5 | 3 | k | ٢. | ~ 1 |  |

Figure 4. Markus (4th year student)

Markus shows that he understands the text and can see how 378 are related to 525. In addition, Markus discerns the parts constituting the whole, but he can not relate these parts to each other in a different way and to the whole. The analyse shows that 55% of the students have the same critical aspects.

It is necessary to specify that the teachers implemented the teaching of mathematics without using the new concept of variation theory as theoretical perspective. In the beginning of the project the focus in the teachers' training was only the concept of critical aspects.

## Phase 2

Based on the identified real critical aspects in students learning and the difference between potential and critical aspects after the first phase, the key concept of the theory of variation was taken up again. In our discussions, we found that it is always beneficial to give students experience in linking subtraction facts with addition facts. This is because a student's memory of both addition and subtraction facts helps the student to understand that each subtraction fact is related to an addition fact. To do this, students need to understand the differences and the connection between addition and subtraction. This means that students need to understand how the parts relate to each other and that the relationship can take many forms. For example, if a child knows that 9 + 8 = 17 and 8 + 9= 17, he or she easily learns that 17 - 9 = 8 and 17 - 9 = 88 = 9. We have found the following two ways for providing experience in teaching the relation between addition and subtraction facts is very

useful and interesting. Besides these, we have identified that students perceive that the larger number comes first when writing subtraction.

On this basis, the teachers implemented 6 lessons. The analysis of teachers' reports shows both the critical aspects that they focused on and the dimensions of variation that they opened up in these aspects. The teachers' focus was for the students to understand: (1) the meaning of the term addition: (2) that a number or an amount can be reduced; (3) understand the difference between addition and subtraction; (4) recognizing the minus sign as a symbol and understand its meaning; (5) be able to decide whether to use addition or subtraction to solve the task; (6) be able to express the addition or subtraction so that the terms are written in the right order; (7) the direction in which they read the subtraction; (8) be able to see a connection between the subtraction and addition; (9) the principle of "tens of themselves and units alone" does not always work; (10) the need to have "an eve on" units in a subtraction: (11) to know that the commutative law is not applicable to subtraction (be able to discern the difference between e.g. 5-3 and 3-5).

In these aspects the teachers opened up dimensions of variation by contrast (3, 5, 6, 11), separation (1, 2, 4, 10), fusion (8) and generalisation (7, 9). Besides these, the analysis of teachers' reports shows that they open up a new dimension of variation (subordinate to generalisation) that will be called *similarity*. The dimension of variations named similarity is defined as the property of two or more expressions to adapt the same meaning.



Figure 5. Dimensions of variation

In the teachers' questions it was identified that they vary the following expressions: left (How much money is left? How much money do you still have? How much cash did you get back? How much change did you get?), missing (How much is missing?), lost, got out, gave away, escaped, sell, left over, less, difference and the opposite. This variation makes it possible for students to develop an understanding from explicit expressions used to mark the operation they have to apply as well as to understand subtraction as the difference. All these opened dimensions of variation are orientated to the meaning of subtraction and how this is expressed. The analysis of students' tests and interviews show that students could understand the differences and the connection between addition and subtraction. For example, the same test was conducted with students in year 2 (involved in the project) and students in year 3 and 4 (which did not participate in the project). The results show that students in year 2 perform better than students in the year 3 and 4. The solution rate indicates that 60% of the students in the year 2, 39% of the students in the year 3 and 37% of the students in the year 4, could solve the exercises that were in the test. Moreover, 95% of the students in the year 4 could solve the task presented in Figure 4.

In the analysis of teachers' reports and students tests/interviews, the same categories as in phase 1 were identified. The relation between the aspects focused on in the classroom and the critical aspects in students learning are shown in Figure 6.



Figure 6. The potential and real critical aspects

The results show that teachers did not only focus on the identified critical aspects in the project's first phase, but they focused on and opened up dimensions of variation in all categories. This led to a reduction in the critical aspects of students' learning.

#### **5. CONCLUSIONS**

Four important discoveries were identified in this study. First, the link between research and teaching is not automatic. The research enquiry helped teachers to see their workplaces and the possibilities for the action within themselves having new theoretical perspectives. Illumination can occur when teachers simply use research to assist their interpretations of students' learning. It can also happen when teachers themselves undertake research and in doing so they use the lenses offered by published research, thus they can systematically examine and develop their own practices and the context in which they are working. In both cases teachers are theorising their practices and exploring the potential available for their deliberate actions. Teachers need the lenses that research can give them for both recognition and analysis of the object of learning in practice. We know that the experts in all activities differ from the novices in the way which they rapidly scan fields, identify what is significant and respond to quite complex interpretations at a level which is sometimes described as intuitive. For teachers to get the opportunity to become experts, they need to focus

in a way which they use the research when scanning, interpreting and responding to learners and learning content. The most important change in this project is to design and implement the research findings to improve the teaching while keeping in mind that learning must be improved as well. A good teaching-learning connection provides active experiences that give students many opportunities to experience new material, and work toward mastery. The critical aspects and variation in those aspects, therefore, are a primary factor in encouraging teacher to improve teaching and students' learning. In order to understand what variations to use in the classroom to improve students learning, it is necessary to understand the varying ways of experiencing the object of learning. Fennema and Franke (1992) named this "changes in teachers' knowledge". In this way it is possible to integrate research with educational practice, in contrast with other researchers' discovery [e.g. 1, 9].

Secondly, the objects of learning intended by the teachers differ from students' lived object of learning (see Figure 3). The teachers' intentions are to enact an object of learning on what students already know instead of focusing on what they do not know. This implies an inefficient communication in the classroom because the students do not encounter an object of learning in the way that is necessary to develop their learning. This is due to differences between potential and real critical aspects. We found that an object of learning can be analysed in a general way in five categories: the whole (A), the parts (B), the relations between the parts (C), the transformations between the parts (D) and the relation between the parts and the whole (E). The most critical aspects in students' learning appear in categories C, D and E. By reflecting to these general categories, the teachers constituted a complete learning object in the sense that they were able to take up almost all critical aspects in the students' learning. This resulted in an essential improvement of student learning. Subtraction is often the point where students become fearful of mathematic and lose their confidence in their ability to master mathematical concepts. It doesn't have to be that way. We also found that the teachers open dimensions of variations in all categories to overcome the critical aspects in categories C, D and E. A new pattern of variation was identified. The dimension of variations named *similarity* is defined in the following way: the property of two or more expressions to adapt the same meaning.

Thirdly, the teacher may enact an object of learning in a lesson that does not express the students need. This means that communication in the classroom is not effective. Teachers' analysis of the relationship between the potential and the real critical aspects enables them to develop the way of experience of the mathematical object of learning and find one correlation between the intended, enacted and lived object of learning. These correlations seem to lead to effective communication in the classroom.

Fourthly, to implement a lesson plan in the relation to the report of the lesson with focus on creating dimensions of variation in the critical aspects of the content seems to be a powerful tool to the teachers' reflective process.

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# New Teaching Experiments for New Learning Strategies How Design-based Research Can Increase Efficiency in Education

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## ABSTRACT

A recent design-based research conducted in the field of vocational training in Switzerland had the particularity of being essentially neither <u>on</u> schools nor <u>in</u> schools, but rather <u>with</u> schools, with teachers and apprentices being closely associated in the process of university level research.

The Swiss vocational training system has the specificity of combining learning in schools and practicing in companies, thus enabling an efficient integration of the apprentices in their professional environments. However, vocational schools are often perceived by the apprentices as being the places of sole theory, whereas the practice at the workplace is considered by them more useful.

The idea that founded the research was that if one could find a way to "bridge the gap" between the two training environments, the efficiency of the training system would be improved significantly. The project aimed at exploring the possibilities offered by the latest technologies to link more efficiently the two learning places. This was done by exploiting mobile phone features, designing blog-like collaborative learning spaces or developing sophisticated computer supported devices.

However interesting the results of the research were, the most amazing thing we noticed is that the main positive effects of the designs were not so much the designs themselves or the possible developments. It was the fact that teachers associated with the research changed their ways of seeing their role and function, introducing a new dimension in their interaction with their pupils and ultimately teaching differently. This opened new and unforeseen perspectives to the research.

Keywords: design-based research, roles, effects.

## FRAMEWORK

#### Scope

The research we are referring to is an on-going project called *Dual-T* that started in 2006 and that associates four university-level institutions of Switzerland: EPFL<sup>1</sup>, University of Fribourg, University of Geneva and SFIVET.

The goal set by the government to the research project is to determine if the use of computer technologies - especially information and communication technologies (ICT) - could help increase the efficacy of the Swiss vocational training system, a complex structure characterized by a close collaboration of the schools with the companies and the trade organizations. The most noticeable feature of this system is that apprentices are offered *curricula* associating, during the three or four years of their apprenticeship, training at a workplace in a company and learning in a vocational school, usually one or two days per week.

#### Efficacy and efficiency

The goal of the research isn't therefore only to produce knowledge. It is also to propose solutions and to give information about the efficacy and efficiency of the solutions the researchers would consider interesting. The costs of the possible solutions to "bridge the gap" between the two learning environments is also expected to be taken into consideration, as well as the possible extension to other trades than those chosen for the studies. This efficiency-oriented requirements lead the project management to opt for a design-based research, an approach that allowed to integrate the many kinds of considerations that had to be taken into account.

#### **Design-Based Research (DBR)**

Design-based research, besides offering an actionoriented conceptual frame-work also carries intrinsically a methodology that seemed the best to produce the requested answers at the end. As stressed by the Design-Based Research Collective <sup>2</sup>: 'Importantly, design-based research goes beyond merely designing and testing par-

<sup>&</sup>lt;sup>1</sup> Ecole Polytechnique Fédérale de Lausanne

<sup>&</sup>lt;sup>2</sup> Hoadley, C., Sandoval, W. et al. (2003), 'Design-Based Research: An Emerging Paradigm for Educational Inquiry' in Educational Researcher, Vol. 32, N° I, pp. 5-8.

ticular interventions'. This aspect of DBR appeared clearly in our study and is going to be the focus of this paper.

At this point we must briefly mention some criticisms expressed about DBR methodology. Chris Dede<sup>1</sup> brilliantly summarized these objections:

'The queasiness about DBR felt by many scholars conservative in their research methods stems from the realization that in DBR studies many variables are deliberately and appropriately not controlled, the "treatment" may evolve considerably over time, and even the research methodologies utilized may shift to fit the morphing intervention. (...)

Further, in much field-based scholarship now conducted (including some DBR studies presented at AERA and ICLS), the research design seems "under-conceptualized and over-methodologized". (...). Certainly, under-conceptualizing and overmethodologizing is not intrinsic to DBR, and some DBR studies result in valuable findings using elegant collection and analysis strategies. Still, the trap of too little thought and too much method is one into which DBR can easily fall, believing that large amounts of data enable one to build on the shifting sands of uncontrolled variables, morphing interventions, and changing research strategies.'

*Dual-T* defined a methodology that addressed these possible weaknesses by a constant exchange between the different sub-projects and a close collaboration with advisory board and steering committee. Above all, DBR, despites of he traps that await the researchers, proved being perfectly able to address all requests imposed on the project.

Why this digression about the specificity of DBR? Because it is going to help understand the principal aspect of this paper, which is not going to discuss so much the quantitative or qualitative results of the specific study it refers to. We are rather going to focus on something unexpected that came into light thanks to the DBR environment, something we were not aware of beforehand and seems to us interesting in a general perspective of education.

## FORMAT

## **Project Dual-T**

*Dual-T* consists of three parallel sub-projects, each conducted by one university. SFIVET, as fourth partner, carries out complementary studies related to the three original sub-projects. Project *Dual-T* is still on-going. A first phase took place from 2007 to 2009. A second one started in spring 2009.

This paper refers to a study carried out by SFIVET and related to the sub-project lead by EPFL. In this sub-project, EPFL developed for logistics apprentices a tangible device reproducing a warehouse at a 1:50 scale and

allowing simulate different kinds of operations a logistician should be able to carry out in real life. The device consists of a camera-beamer combo fixed over a wooden board and associated with a sophisticated computer software developed in the frame of the project. The device registers with the camera the displacements of the objects (shelves, offices, etc.) moved on the board and simultaneously projects on the board an image of the result of the actions (movements of fork-lifts, info on efficiency of the installation, etc.). (*See Figure 1 below*)



Figure 1: Apprentices working with the device developed by EPFL

## **SFIVET** contribution

While EPFL documented the process of learning with the device, SFIVET focused on the teachers actions, to determine whether the design would change their ways of teaching. The main research questions were:

- 1. What is the added value of the device for the teachers?
- 2. What effect is the device going to have on their teaching?
- 3. What didactic scenarios (Learning Unit Plan) can be based on the use of the device? Can they contribute to reduce the "gap" between school environment and workplace reality?

SFIVET contribution started in summer 2008. A first phase of observations took place in a vocational school in Thun, Switzerland, with 3 classes (48 apprentices). Data collection consisted in questionnaires (to get the feedback of the apprentices), teachers' log-books, semi-structured interviews with the teachers, video tapes and tests of competencies (comparison with apprentices working standardly, without the "tables").

## **RESULTS OF THE STUDY**

## **General observations**

First of all, a general statement must be made about the whole picture, before focusing on the aspects regarding exclusively the teachers. The most important observation

<sup>&</sup>lt;sup>1</sup> Dede, C. (2004), 'If Design-Based Research is the Answer, What is the Question?' in *The Journal of Learning Sciences*, 13, pp. 105-114

we made is that the apprentices highly appreciated using the device (98%). The most cited reasons given through the questionnaire to explain this appreciation were: fun, learning by playing, comparison between teams (challenge), autonomy, real-time feedback on any action.

#### Added value of the device

The device's added value to the training/learning process consists primarily in its real-time feedback feature. The apprentices appreciated the visualisation of the forklifts' movements (50%), the real-time registration of their moves on the board (30%), the autonomy given to them in their learning process (30%).

The teachers, on their side, expressed in the interviews and log-books their satisfaction to see that the machine did a great part of their usual job, by giving answers to the apprentices. Indeed their students spent a lot of time interacting with the device without intervention of the teacher. This time of autonomous learning amounted up to 70 % of the total course time in the last days of the observed experiment. (See figures 2 and 3 below). However the teachers claimed in the final interview that it was difficult for them to appreciate correctly the benefit of the device because of the stress that accompanied the whole experiment and the fear that things could "turn wrong".



Figure 2: Autonomous Learning - Interaction with Teacher Ratio

### Effect of the device on teaching

The teachers changed progressively their interactions with their classes. This is firstly attested by the time they spend with the apprentices. This time went decreasing until at the end, the teachers let their students work alone roughly 50% to 70 % of the time. (See figure 3 below).

| Class<br>Each class has<br>2 tables (2 teams) | Interactions<br>with both teams<br>simultaneously | Interactions with team 1 | Interactions with team 2 | NO<br>Interactions |  |  |  |  |
|---|---|--------------------------|--------------------------|--------------------|--|--|--|--|
| 4   | 13.7  | 14.2                     | 24.6                     | 47.5               |  |  |  |  |
|   |   | 10                       | 00                       |                    |  |  |  |  |
|   | 3.8   | 25.5                     | 13.7                     | 57.0               |  |  |  |  |
| 2   |   | 100                      |                          |                    |  |  |  |  |
|   | 0   | 11.5                     | 19.8                     | 68.7               |  |  |  |  |
| 3   |   | 100                      |                          |                    |  |  |  |  |
|   | 0   | 19                       | 19                       | 62                 |  |  |  |  |
| 4   | 100   |                          |                          |                    |  |  |  |  |

Figure 3: Percentage of the time the teachers spent with the teams of apprentices

4. It is secondly attested by the nature of their interactions with the groups at work: all of them passed from a traditional explanation & exercise-supervision pattern to a loose coaching practice focusing on the learning strategies that could be observed while the apprentices, mainly in group of 2 to 4, learned with the devices. (See Figure 4 below)



Figure 4: Example of the evolution of a teacher's teaching style

In the interview that concluded the study the teachers started to question their role and fonction. However, it was difficult for them to make the distinction between the elements that were momentary and the ones that would remain after everybody get used to the "tables".

This analysis was made even more difficult because of the fact that during the whole experiment, the teachers were also developers, testers, counselors, discoverers and supposed to get a result, since the course was a "real" one. Nevertheless, it appeared repeatedly in the interview that teaching with this device would represent a major change in the teaching. But which one? This is going to be discussed in the next section.

### **Didactic scenarios**

Teachers were involved in the research and associated with the development of the software. Every step of the development was thoroughly discussed with them. This aspect of the project guaranteed an efficient integration of the device in the learning program. Now does the device allow the creation of new scenarios? Actually, the use of the "tables" is in itself a completely new scenario. Its potential still has to be explored and exploited, This is going to take place in the next phase of the project.

### Bridging the gap

Now, did all this help bridge the gap between the two learning places? With this question, we quit the domain of data since bridging a gap is a metaphor. But if we let aside the rethoric considerations, we can affirm that de device certainly helps bridge the percieved gap, since the "tables" simulate at school the working place environment and offer a space for reflection, analysis and teamwork that are closely related to everyday practice in a company.

## DISCUSSION

## Levels of change

At this point, it is useful to take a step back and consider the whole picture again. What are we talking about? Efficacy of a method? Efficiency of a system? Performance enhancing strategy? Computer technology? Development of teachers' competencies? Economics of vocational education? Or are we talking about something else, that could sound like fun, challenge, future & identity, as suggested to us by odd words written down in the questionnaires or expressed in interviews? Remember what the DBR Collective wrote: 'Importantly, design-based research goes beyond merely designing and testing particular interventions'. Let's then go beyond the limit of mere measuring and let's have a glance at the field opened by our DBR.

Basically, we are in a context of change, of evolution, of adaptation to new possibilities and new requirements. In such a context, Gregory Bateson's diagram <sup>1</sup> appeared to us the most appropriate tool to help understand what is going on. (*See figure 5 below*).

| TRANSCENDENT     |
|------------------|
| IDENTITY         |
| VALUES & BELIEFS |
| COMPETENCES      |
| BEHAVIOR         |
| ENVIRONMENT      |

## Figure 5: Gregory Bateson's Logical Levels of Learning and Change, as summarized by Robert Dilts

Usually, at least since a few decades, focus in training structures is put on competences, what corresponds to Bateson's Level 3. The commonly admitted presupposition is that people need more competences and that the job is done when the training of the new competences is over. This proved to be wrong<sup>2</sup>. Change has effect on all levels identified by Bateson and all of them must be redefined according to the change that occured on the level of competence. If not, there is no real change. Typically, people have to believe that they can now use what they have learned (Level 4) and they must behave consequently (Level 2). What has been learned must be translated into action (Level 1) and has an effect on Identity (Level 5).

If a lot of training courses have so little effect, it is because they address only the level of competences. Without a further "realignment" - the building of a new coherence through the different levels - there is no real new competence.

If we consider from Bateson's perspective the set of competences the teachers have to develop in order to be able to use at its best the environment centered on the use of the "tables", we notice an interesting configuration: the design addresses simultaneously Level 1 / Environment (by imposing a new environment) and Level 5 / Identity (by challenging the role, *i.e.* the identity of the teacher). Interestingly, it does not expressly address the level of competences, although the coaching of apprentices learning with the tables requests obviously new competences from the teachers. The building of eventual new teacher competences in the context observed in our study can be schematized like this:



This situation has similarities with what Lave and Wenger<sup>3</sup> called situated learning environments and with the learning contexts analyzed by Hansman and Wilson<sup>4</sup>, who showed how people develop their competences within communities of practice. See also ERIC<sup>5</sup> digests for examples of this.

The situation has also similarities with a design we experienced a few years ago in a grammar school with 15 year old students who had learning difficulties and who's behavior was considered troublesome. To find a solution to the whole set of problems created by these adolescents, we designed a completely new environment characterized by the creation of small virtual enterprises, professional activities, contractual collaboration among the groups, responsibility, etc. No more 45 minute lessons, no more sitting on chairs and listening, no more homework. This new environment proved so efficient that it was continued and still works as designed 10 years ago. Now, if we could observe a lot of interesting things concerning the students, it was equally interesting to observe what had happened with the teachers. They had to adopt new be-

See Dilts, R. and DeLozier, J. (2000), 'Levels of Learning and Change', in *Encyclopedia of Systemic Neuro-Linguistic Pro*gramming and NLP New Coding, p.645-648

<sup>&</sup>lt;sup>2</sup> See Piaget, Bourdieu, Vygotski and others

<sup>&</sup>lt;sup>3</sup> Lave, J., & Wenger, E. (1991). 'Situated learning: Legitimate peripheral participation', Cambridge University Press.

<sup>&</sup>lt;sup>4</sup> See Hansman, C. & Wilson, A. (1998) 'Cognition and P<sup>4</sup>ractice: Adult Learning Situated in Everyday Activity', at http://www.edst.educ.ubc.ca/aerc/1998/98hansman.htm. See also *References* below

<sup>&</sup>lt;sup>5</sup> Education Resources Information Center (http://www.eric.ed.gov/)

havior because they could no longer use their habitual ways of teaching in the environment created by the design and were dramatically challenged in their identity. They were simply no more teachers, but directors, coaches, supervisors, contractees, partners in projects, etc. They rapidly forged a whole set of new beliefs - some of them basic ones like those concerning who they are, what the role of a teacher is, etc. - As a result, they developed new competences that matched their shifts on the higher levels and addressed the requests on the lower levels.

This experiment was not documented so as to present evidences showing how fast the acquisition of the requested competences was and why it proved itself so efficient while having no scaffolding, no training course, no assessment. Whatever lacks in the documentation of this experiment, it is obvious that in the light brought by Bateson's levels of change diagram we can see the similarities with the environment created by the EPFL *Dual-T* design: in both situations, teachers were forced by the context to develop new competences, while challenged in their identity as teachers.

These considerations help shape the answer to the question raised at the beginning of this section: What exactly are we talking about? We can now better see that if the questions of those who financed the research concerned essentially efficiency and possible generalization - something that is relevant to Bateson's Level 1 - the answers switch immediately to higher levels. So what? Are we at a dead end? Not so!

## **Systemics**

The focus on the levels may lead to a representation that lacks movement and interaction. In fact, what we are talking about is a process. Everything that was observed was actually changing, evolving, interacting with other elements. This aspect is even the most important of all. The study tried to keep track of that in documenting the changes in the teacher's behavior and beliefs over time. But there are other "movements" than the mere modification of points of view, the creation of new beliefs, the rejection of old ones, the reconsideration of values or the rearrangement of priorities. First of all, we must keep in mind that *everybody* is changing in the process of DBR: the apprentices, the teachers, the developers, the researchers, etc. DBR is based on conjecture maps, on a net of interconnected presuppositions. These maps evolve over time. This fact is considered by some as a weakness, because it lacks rigor. But it has the advantage to reconsider constantly the validity of the postulates. It has also the even more important advantage to integrate "at the root" the dimension of time, of evolution and to acknowledge this basic variable by "moving" with the elements it is observing.

## Stakeholders

If we adopt a sociologist's point of view, we notice that the relations between the various "actors of the play" in the DBR context changed from what they are in normal conditions. In everyday school life, teachers have the knowledge and the administrative power while the apprentices are in a position of "not-knowers", must learn and follow instructions. In the end there are assessments to verify if they are compliant with the model.

In DBR context, the situation is totally different: the apprentices become partners. The team of researchers and developers are listening attentively to them. What they do is important, they got a importance that did not exist before. Their actions are a valuable contribution to a project aiming at creating a "better world". *(see figure 6 below)*.



### Figure 6: Apprentices' answers to questions concerning the use of the table

All this is a major change, which is going to have effects on all the levels mentioned before. Considered like this, learning, in the frame of the project, becomes something new, something more exciting. As a result, they learn with pleasure. And better, according to what they say<sup>1</sup>.

If we apply the same observation to all the stakeholders of the project we will notice that all of them are in a similar dynamic of "gaining".

If we link this set of observations with what we said before, we finally have a consistent picture of the development.

### Conclusion

By making a link between the observations made in our study and Bateson's levels of change, we do a huge step forward when we try to understand the changes generated by the design.

By applying then a systemic approach to our analysis while keeping in mind that what we observe is a process

<sup>&</sup>lt;sup>1</sup> At end tests, the apprentices who learned with the "tables" got the same results as their fellows who had learned in standard courses. In other words, it did not appear in these tests that they were more competent than their fellows. But here we have to add a remark: the tests were ordinary school tests, designed to check specific capabilities related to the course objectives, not more nor other capabilities. In the case of the courses observed in the study, we noticed that a lot of competences not mentioned in the curriculum played an important role. Since teamwork was the basic learning configuration, all aspects of collaborative learning were displayed (reflection, verbal expression, listening to arguments, integration of new facts in the construction of suppositions, etc.). We can assume that this interactivity developed quite a bunch of competencies not considered in the the school tests, but highly important in professional life.

and not a still picture, we do another step forward in the understanding of this process of change.

By finally clarifying the role all stakeholders play in this process - be it voluntarily or unconsciously - we see many doors open for all of them.

DBR's constant rearranging of the conjectures - and including in the research everyone who plays a role in it besides of proving itself an efficient research methodology, offered everybody the opportunity to benefit from it. It helped the researchers refine their conjectures as the context changed. It helped the developers build more efficiently their device, it helped the teachers develop new competences and "revisit" their beliefs, it helped the apprentices integrate the world of adults, by being considered as full stakeholders in the designing process. This last aspect of DBR in education is possibly the most promising. If, indeed, the ultimate desired outcome of *Dual-T* research is to build a more efficient training environment, do it with the apprentices instead of for them may be worth considering.

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## The Contribution of Virtual Reality Software to Design in Teaching Physical Education

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#### ABSTRACT

Up to date research shows that training with virtual software develops the design of virtual simulations by physical education pre service teachers. The design of virtual simulations improved spatial skills, especially visualization of the body's movements in space. The present research is aimed at testing and developing physical education pre service teachers' awareness of the connection between the virtual simulation design and physical education activities. This is done by using Tetris software, consequently improving lesson planning. The study design focused on a qualitative research using a post-test open ended questionnaire for getting the participants' opinions, and comparing the pre service teachers' performance of virtual simulation design before and after the training with the Tetris software. The findings showed that as software use increased, the connection between the design of virtual simulations and physical education became clear to the pre service teachers. Also the pupils became involved in the virtual simulation design. Using computer presentations in their practical work, the pre service teachers reported improvement in pupils' physical skills. Moreover, the pre service teachers' motivation was enhanced. All the findings lead to the conclusion that virtual simulations design seem to mediate between developing physical skills involving running, jumping, etc. and spatial intelligence.

**Keywords:** Design, Delight, Dynamic, Manipulation, Physical Education, Practical Work, Software, Virtual Reality, Virtual Simulations and Visualization.

#### **1. INTRODUCTION**

Recently, research on the connection between the design of virtual simulations and physical activities has been developing (1) (2) (3) (4) (5) (6) (7).

Seemingly, these two areas are contradictory since most physical educators do not associate virtual simulations with physical activities, but with science (8), medical imaging (9) (10) (11), computer games (12) (13), etc.

The virtual simulation design enables pre service teachers to illustrate sequences of movements while changing body positions and perspectives. Consequently, they perceived the process by which the movements are performed (14), as the virtual environment simulates the learner's natural environment. Virtual simulations offer pre service teachers the unique opportunity to observe and manipulate normally inaccessible objects, variables and processes in real time and design it appropriately (2) (15).

The illustration of objects makes learning more straightforward and intuitive for many students and supports a constructivist

approach to learning. Students can learn by doing rather than, for example, reading about them. They can also testify theories by developing alternative realities. This greatly facilitates the mastery of difficult concepts, for example, the relation between distance, motion and time (8). Manipulating the body or the objects virtually help the students to understand the process of performing physical acts by sequentially (14). Physical manipulations that are complicate to perceive or to measure in usual experiments can be presented in a virtual world and viewed in many different perspectives in a virtual reality laboratory. Virtual reality technology allows the participant multisensory experiences coming from perceptual information visual, auditory, and tactile stimuli. According to Pizer (as cited in Reingold (16)) the main advantage of Virtual Reality regarding perception is the ability to move and change our view of things as we would do in the real world in order to give us an adequate perception. Virtual Reality technology is developing interfaces that mirror more natural human behaviors and the given physical laws governing the objects they interact within the environment. Dynamic Simulations allow visualizing complex dynamic processes (17). Visualization enables us to show information that would otherwise not be available (18).

The research of augmenting virtual environment examined three spatial training displays: first-person view, overhead-map view or first-person view with integrated map (composite view). Participants learned the locations of seven targets in a computer simulation of a building. Spatial knowledge for these targets was assessed in the physical building. Results indicate that both the type of training display and spatial ability predicted performance level and that the utility of the composite display was a function of spatial ability and task. Success in navigational learning from the simulated environments is depended on a complex interaction between spatial ability, navigational task, and type of training display (1).

The individual needs his spatial intelligence for his body's movement and computerized activities, for example: while using the computer, he is required to move an object through the maze to a marked target. But in body movement, he must run through the course without bumping into barriers or obstacles.

The integration of physical and virtual movements improves spatial intelligence (14) (19).

The main similarities between virtual simulations and physical activities are as follows. Both experiences include initiated motor activities and require inter-sensory coordination; both experiences refer to the basics of the motion: body, space, time, power and flow.

The virtual (computerized) activities also differ from physical activities in some aspects (see Table 1).

Table 1: The Differences between virtual Activities and Physical Activities.

| Virtual Activities   | Physical Activities                    |
|--|--|
| Performed by fingers – fine                                  | Done by the whole body –               |
| motor.   | gross motor.                           |
| Based on visual perception.                                  | Based on kinesthetic perception.       |
| Can be done individually or communicatively.                 | Serves usually also as a social event. |
| Focuses on information<br>appears on the computer<br>screen. | Relates to the environment             |

#### 2. THEORETICAL REVIEW

Up to date research shows that virtual software for developing spatial skills enables learners to both develop and improve academic achievements (5) (20) (21) (22).

#### The Tetris Software

Pazhitnov (23) invented the Tetris Software in 1985. Since then, this software (computer game) was considered as the hardest task exemplifying problem solving by manipulating virtual reality, while the users race to fit falling blocks together. In the game, the player sees the shapes' aggregates graphically and tries to organize them before they fall (20). It links the concrete and the symbolic by means of feedback. The manipulations of the shapes' aggregates over the computer screen (rotating them to the right or to the left side) link the symbolic commands to a sensory-concrete turning action (24). The game exploded in popularity after Nintendo Co. and people put it on their popular gaming machines.

#### **Tetris Software and Virtual Reality**

Virtual-simulated environments are becoming more and more realistic, offering a real-world experience. Pantelidis (25) defines Virtual Reality (VR) as a multimedia interactive computer-based environment that allows the user to assimilate and become an active partner in the virtual world. The technology enables presenting information in three dimensional formats in real time (26) (27). Through virtual reality learning environments, the users can control time, scale and physical laws. The users have unique capabilities such as the ability to fly through the virtual world, to occupy any object as a virtual body. To observe the environment from many perspectives is both a conceptual and a social skill: enabling pupils to practice this skill in ways we cannot achieve in the physical world is a valuable attribute of virtual reality.

The Tetris Software focuses on visualizing shapes' aggregates appearing over the computer screen, randomly and rapidly changing their position in space, while manipulating them as required. As the software users' skills increase, their level and speed also increase. The software helps to explain the structure of the shapes' aggregate and the connection between real shapes and their mental image by giving immediate feedback (24).

Computer-generated models or simulations are increasingly finding their way into areas such as building design and safety, air-flight training and controlling, medical training and surgery, transport systems, and ergonomics, as well as tourism and education. Under the label of 'entertainment,' video arcades and home computers now offer up a range of electronically generated simulations of activities such as auto racing, golf, football, skiing, boxing, and basketball (28). Table 2 exemplifies the connection between the activities performed while training with Tetris software and the ability to analyze motor skills (see Table 2).

Table 2: An example of the connection between the activities performed while training with Tetris software and the ability to analyze motor skills

| Training with    | Design             | Analyzing passing the      |
|------------------|--------------------|----------------------------|
| Tetris           |                    | handball                   |
| software         |                    |                            |
| The shapes'      | The designer       | The pupils/players stay    |
| aggregate        | holds the design   | on the court.              |
| appears at the   | tool.              |                            |
| upper part of    |                    |                            |
| the game board   |                    |                            |
| Predicting the   | The designer       | The pupils/players check   |
| direction        | checks and         | and choose the distance    |
| required for     | chooses the        | of their body from the     |
| planning the     | appropriate        | other participants so that |
| next step in the | position of the    | the ball can be easily     |
| game.            | design tool and    | caught by one of their     |
|                  | its distance from  | team-mates.                |
|                  | the sheet of       |                            |
|                  | paper.             |                            |
| Adjusting the    | The designer       | The pupils/players adjust  |
| shapes'          | adjusts the        | the position of body by    |
| aggregate to the | design tool to     | holding the ball for       |
| appropriate      | the appropriate    | passing to one of the      |
| direction.       | direction          | other players.             |
|                  | relating to the    |                            |
|                  | starting point of  |                            |
|                  | designing.         |                            |
| Navigating the   | The designer       | The pupils/players pass    |
| shapes'          | navigates the      | the ball from one hand to  |
| aggregate down   | design tool        | the other while dribbling  |
| and then to the  | down and then      | it from one side to the    |
| right or to the  | to the right or to | other side of the court.   |
| left side.       | the left side.     | Sometimes they have to     |
|                  |                    | jump to pass the ball.     |

The data presented in table 2 show a parallelism between the training with Tetris Software and the stages of designing and those of passing the handball. Such a parallelism also exists with additional motor skills such as swimming, football, tennis, etc.

### Virtual Reality and Motivation

The use of virtual reality enhances the motivation of its users, thanks to the possibility to make objects appear, disappear and transform. Zaretsky (29) indicated that many participants in her research, including students in colleges and pupils in schools, are more active and dynamic during the computerized activity, especially if the activity concerns creating simulations. The duration of concentration also increases.

The students learn and then teach the pupils how to observe the body movements, interpret, imagine and simulate virtually and in the real world, using knowledge research, deliver more knowledge of delights of life.

Glanville (30) suggested that "it is easy to do the well made and useful part of the equation, but that what is difficult is the 'delightful' and that this requires the designer to do more than is necessary, to make something better than what is there. It is the more than necessary that is the necessary bit – it is what brings the delight".

#### 3. RESEARCH PRESENTATION

The study design focused on a qualitative research using a posttest open ended questionnaire for getting the participants' opinions, and comparing the pre service teachers' performance of virtual simulation design before and after the training with the Tetris software. The participants in the research, thirty firstyear physical education pre service teachers, noted their achievements using Tetris software, and responded to an open ended questionnaire stating their opinions regarding the connection between training with Tetris software skills and designing virtual simulations for physical education lesson planning and teaching. The research lasted four months and included four stages:

- 1. Learning to design computer presentations;
- 2. Training with Tetris software and its analysis;
- 3. Designing virtual simulations in teaching units for their lessons;
- 4. Writing their analysis relating practice to theory.

The research questions are:

What is the connection between practicing with Tetris software skills, design and physical activity?

How can training with Tetris software skills impact on design and physical education lesson planning, through creating virtual simulations?

#### Media

The Computer software "Tetris Game" was used to examine its connection with physical skills. The players aim at filling three dimensional shapes' aggregates into rows and a large three dimensional cube with small shapes' aggregates. During the use of the Tetris task, block-shaped pieces appear at the top of the screen and fall down, while players manipulate them, so that they fit into point-scoring rows. In order to attain a high score, the users need to act precisely and rapidly. The users have to complete the blank locations on the game board according to an induced rule he had inferred and fit the appropriate shapes' aggregate in the blank locations.

The Tetris Software is characterized by the following:

- 1. Each shapes' aggregate appears at the upper part of the game board and is going down in a constant speed.
- 2. The degrees of difficulty are determined by the speed in which the shapes' aggregate moves down.
- 3. At any time when the line or the surface in the three dimensional Tetris game is filled, it is erased and the participant attains points.
- 4. The keys for training with the "Tetris" software are the same: The user can move the shapes' aggregate to the right or to the left side, or to take it down by using the arrow-keys. The shapes' aggregate can be rotated to fit the empty space to be filled by the use of the space bar, by 90<sup>0</sup> to the right or to the left side. The use of "Tetris" Software trains Spatial Orientation and Visualization, motor skills, eye-hand coordination and time orientation.

#### 4. FINDINGS

The pre service teachers' gains in points in Tetris software show a gradual increase of points, practicing with the software. Observing all the pre service teachers included in the research group, practicing with Tetris software revealed their progress and interest. In order to illustrate it, Table 3 presents the functioning of 6 pre service teachers that participated in this group (see Table 3).

| Table 3: Examp | oles of points | s gained by | a representative p | part of the | participants v | while training the T | <b>Fetris Software</b> |
|----------------|----------------|-------------|--------------------|-------------|----------------|----------------------|------------------------|
|                | 1              | <u> </u>    | 1 1                |             |                | 0                    |                        |

| Participant          | Partici | pant 1 | Partici | pant 2 | Partici | pant 3 | Partici | pant 4 | Partici | pant 5 | Partici | ipant 6 |
|----------------------|---------|--------|---------|--------|---------|--------|---------|--------|---------|--------|---------|---------|
| Levels and<br>trials | Level   | Trial   |
|                      | Level   | 95     | Level   | 1661   | Level   | 1382   | Level   | 365    | Level   | 91     | Level   | 3835    |
|                      | 2       | 110    | 2       | 2820   | 1       | 1517   | 1       | 475    | 2       | 216    | 1       |         |
|                      |         | 425    | Level   | 3275   | Level   | 3750   |         | 1450   |         | 280    | Level   | 3251    |
|                      |         | 440    | 1       | 3531   | 3       | 4406   |         | 2356   |         | 661    | 2       |         |
|                      |         | 510    |         | 4236   |         |        |         |        |         | 1236   |         |         |
|                      |         | 1020   |         |        |         |        |         |        |         | 1565   |         |         |
|                      |         | 1715   |         |        |         |        |         |        |         | 1680   |         |         |
|                      |         | 1955   |         |        |         |        |         |        |         | 2255   |         |         |
|                      |         | 1970   |         |        |         |        |         |        |         | 2301   |         |         |
|                      |         | 3210   |         |        |         |        |         |        |         | 2417   |         |         |
|                      |         |        |         |        |         |        |         |        |         |        |         |         |

Gains acquired by pre service teachers.

#### The Contribution of Tetris Software to Physical Skills According to the Answers Given through the Open Ended Questionnaire

The pre service teachers filled the open ended questionnaire before and after practicing with Tetris Software.

Before training with the Tetris Software the connection between this software and physical skills was not clear to the pre service teachers.

But after the training:

A comparison of the pre service teachers' gains in the Tetris software with their answers to the open ended questionnaire indicated that as the use of the Tetris software as well as the gains increased, the pre service teachers became aware of the connection between manipulating virtual reality and physical activities. Consequently, the pre service teachers gradually improved their PowerPoint presentations. They planned the virtual movements over the computer screen, for example: running, swimming, jumping, etc.

| Skill                         | The Answers  | Design  |  |  |  |  |
|-------------------------------|--|---|--|--|--|--|
| Planning                      | Predicting and planning the next<br>movement/position in space that<br>applies the given situation.  | Predicting and planning the next line of<br>shape of the design that applies the<br>former line(s) or shape(s). |  |  |  |  |
| Thinking                      | Thinking precisely and rapidly,<br>Developing spatial and motion<br>thinking,<br>Improvising movements in rapidly<br>changing environment,<br>Fitting the pace of action accordingly,<br>Responding rapidly. | Developing the spatial thinking.  |  |  |  |  |
| Orientation in<br>Space       | Orienting in narrow spaces,<br>Controlling the directions in space in<br>different environments.   | Orienting in narrow and wide spaces,  |  |  |  |  |
| Motor                         | Developing fine motor.   | Developing fine motor.  |  |  |  |  |
| Body Image                    | Increasing body balance.   | Increasing hands balance.   |  |  |  |  |
| Agility                       | Developing agility while performing motor activities.  |   |  |  |  |  |
| Concentration and Persistence | Improving concentration and persisting<br>on the task until succeeding it.   | Improving concentration and persisting on the task until succeeding it.   |  |  |  |  |

Table 4: Samples of answers regarding the impact of Tetris Software on Design and Physical Skills

The pre service teachers answered for example:

"The use of Tetris software can improve quick response while predicting the next line, shape or step"; "Training with Tetris software develops the cognitive ability by planning movements, setting goals, thinking rapidly, persisting on the task until succeeding it. All these skills lead to the ability to correctly enact the body in real-time situations".

The pre service teachers stressed the impact of Tetris Software on the design of sportive activities by sequentially such as gymnastics and specifically ground gymnastics, basketball, tennis, shooting, light athletics, competitive tournaments, ball games, collective games, activities that require alertness and using adequate strategies. Some of the pre service teachers included in this category all the sport branches that lead to win. See for instance the citations as: "The Tetris software affects each game that requires thinking, for example, we can see the next step of attack in basketball game"; "The Tetris software affects Challenging activities such as basketball game which simultaneously enacts **thinking** and **motor** acts"; "The Tetris software affects planning strategies for the long term, while performing a relay race task, etc.".

The similar challenge of gaining points characterizes gaming Tetris Software, Sport games and also in competitive tournament, while wishing to win. Tetris game (software) as well as basketball, marksmanship, etc. improve eye-hand coordination. The answers given about the similarity between the Tetris software and physical skills were such as "Both kinds of activities enable the body/fingers presenting in different positions or directions in space. They also enable planning the movement in advance".

Simultaneously, the pre service teachers improved their level of using computers by training them to gradually use and create digital simulations of movements in space, when their selfimage as computer users was improved. Consequently, the pre service teachers' ability to build virtual reality by using the computers improved their planning and the exercises they made for their physical education practical work. Afterwards the pre service teachers used their presentations with pupils and reported a progress in performing physical activities, especially jumping, gymnastics and specifically ground gymnastics, shooting and movement games.

In this context, the design skill comes to fruition while performing activities such as designing the path before animating the movements of figures passing through the path.

#### 5. DISCUSSION

The questions raised in this research are: what is the connection between practicing with Tetris software skills, design and physical activity, and how can training with Tetris software skills impact on design and physical education lesson planning, through creating virtual simulations?

Comparing the implications of Objectivism to those of Constructivism reveals the significance of virtual reality to education. According to the constructivist theory, the Immersive Virtual Reality enables first-person experiences by removing the interface that acts as a boundary between the participant and the computer. This is the only way, in which each person visually constructs his/her knowledge of the world, experiencing in the real world, as portrayed by the Computer, without the need for symbolic descriptions of the experience (31). In this context, we should emphasize the role of the computer as a mediator of the movement design.

Virtual reality environment is unique in its dynamic representation. It adds an animation to the design product.

Succeeding to create simulations of the real world enhances the motivation and delight of the participants to practice their studying. Consequently, the participants added a lot of simulations fitting the physical reality.

The research exemplifies the effects of the manipulation of shapes' aggregate rapidly moving on the computer screen. Besides the challenge of the computerized activities, it helps to build physical competence.

Some methods focus on manipulations allow and even encourage students to choose their own representation(s) material, can also be used to assess whether students understand the idea or just have learned to use material in a rote manner. Certain virtual manipulations encourage easy alterations of scale and arrangement, thus they go beyond what can be done with physical manipulations and demand increasingly complex and precise specifications. The Computer Manipulations guide students to reflect on their actions and alter them by predicting and explaining (32). The pre service teachers succeeded to apply the Physical Education theory in their practical work through the PowerPoint presentations, initiating from their need to understand the meaning of the movements and their design, the relationships between them and how to perform them successfully.

#### The Uniqueness of the Method

The uniqueness of this method focuses on the object(s) design and manipulation over the computer screen by the learner himself as appear in many software games (33). Generally, all or most computer games train spatial orientation and visualization, as the player has to orient himself/herself within a rapidly changing environment. Players of the computer game Tetris Software may choose to preview each upcoming shape in order to plan the next step in playing the game, manipulating the fast changing environment over the computer screen. The same skill is needed for designing and performing physical movements. (34).

Success in the game that is "gaining the points" has its motivating effect on the participants and thus enhances the effect of the training.

The contribution of virtual simulations to design and physical activities is thus focusing on the important findings as following:

- Allow to visualize complex dynamic processes (17)
- Improve three dimensional visualization and spatial intelligence.
- Develop the ability to recognize three dimensional shapes (35)
- Assist in decoding the problems and improve the performance.

#### 6. SUMMARY AND CONCLUSIONS

The present study indicated that the use of the computer enhanced the thirty pre service teachers' awareness of the connection between the design and manipulation of virtual objects through the performance of virtual and physical activities. Moreover, the pre service teachers' creation of digital simulations, especially while performing complex ones, was improved. According to the pre service teachers' report about improving their pupils' physical skills, it seems that the design and virtual simulations serve as a mediator for developing physical skills such as running, gymnastics and specifically ground gymnastics, etc. During the virtual training process, which facilitated the virtual mode, the pre service teachers learned how to improve their planning physical movements in order to perform them successfully and fluently by sequentially. These improvements were also used to design their teaching programs for their future pupils.

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## Ordered Structure of the Thesaurus of Word Roots of German Language

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## ABSTRACT

The frequency lists of words exist for different languages, where the frequency of occurrence is inversely proportional to the rank of the word. This is called Zipf law. We compiled the frequency list of the roots of German words. 30000 most often used words use about 1800 German roots. In contrast with the words, the functional dependence of the frequency of occurrence for the roots is drastically different - it is exponential. About 44 top German roots deviate from this dependence, being used even more often. The observed regular behaviour of roots, together with the results of our previous work, led us to conjecture, that all the word roots are represented at the cortical surface of human brains in a confined area. The position of any root in this patch of neural tissue determines the frequency of use of this root in the everyday speech. Other elements of speech, prefixes, for example, are represented in another patch of cortical tissue. Existing axonal interconnections between these areas determine allowed combinations - that is words.

**Keywords**: Speech, Word Roots, Frequency of Occurrence, Cortical Representation of Language.

## **INTRODUCTION**

Speech communication with the computer turned out to be quite challenging task for the computer science. In spite of enormous computation speed and huge memory of the present day computers, they most often fail to interpret vocal messages from human beings. Software is very good in many applications, chess for example, and still, real brains highly outperform computers in the analysis of the stream of sounds and extract the elements of speech "fluently". The auditory system of the brain converts the pressure variations in the ear into the sequence of meaningful elements perfectly, in spite of low speed of neural computations and limited capacity of the working memory. Most probably, the specific organization of the speech perceiving system in humans, drastically different from what is implemented now in the computers, makes this system so efficient. One should look in more details how the neural system supporting language is operating. The available linguistic data, when properly analyzed, provide background for plausible

assumptions on the possible arrangement and functional structure of the brain areas involved in speech production and language perception. The emerging inferences can be the subject for experimental tests using sophisticated noninvasive techniques such as Functional Magnetic Resonance Imaging (fMRI) or Multi-channel Magnetic Encephalography (MEG) [1,2].

We are trying to get the idea of how just the speech is perceived (and generated), since the acoustic system performs many different tasks processing incoming sounds. These tasks are common for many species, while the language is the distinctive feature of Homo Sapiens. Speech uses characteristic elements - phonemes, to convey information. Only few of possible combinations of phonemes can be used to produce intelligible speech. The basic combinations (we consider Indo-European languages here) are affixes and roots, which concatenate to form words. The words of different types (nouns, verbs, adjectives etc.) can follow each other only in definite sequences. The use of predetermined combinations distinguishes intelligible speech from the chain of nonsense words or the ravings of a madman uttering quite correct words. Any computer designed to "understand" human speech should have a database of the correct elements of speech. In general we know how this electronic database is built. We wonder how the more efficient human "database" is implemented in the neural tissue of the cortex? We believe that linguistic data can shed light on the layout of such a database.

## COMBINATIONS OF THE ELEMENTS OF SPEECH

We started our research on the hierarchical level of the combinations of words – Russian verbs and adverbs in particular [3, 4]. One can construct the table of compatibility of verbs and adverbs so that the value on the crossing of row "*jump*" and column "*bravely*" equals 1, since they can be used together. The value in the cell "*jump*"-"frankly" is 0, since this verb is incompatible with this adverb. The "fuzzy" cases are attributed with the value 0,5. The table for 900 basic verbs and 600 adverbs, was compiled, including most frequently used words. The verbs can be represented as multi-dimensional vectors with 600 components equal to 0, 1 or

0,5. It turns out that the 9-dimensional space is sufficient to fit in the array of individual vectors for verbs, which are scattered homogeneously in a portion of this space. The verbs compatible with many adverbs are at one side, while those forming few combinations are on the other side of this constellation of points. The same holds for the vectors with 900 components describing adverbs. Such a result led us to the assumption that there exist adjacent portions of the cerebral cortex where representations of verbs and adverbs are stored. Verbs and adverbs, forming many combinations, are located nearby, while the verbs matching few adverbs (and vice versa) are on the far ends of the corresponding cortical patches. Since words follow each other quickly in fluent speech and there is no time to check through neural computations correct match of the words, we conjecture that the "permitted" pairs are directly linked with the axonal connection between cortical patches, while the "forbidden" pairs lack such a link.

Starting from this result we turned attention to another level of combinations - Russian prefixes and word roots [5]. Using similar approach we calculated positions of Russian prefixes in two dimensions. This probably means, that there exists a portion of the cortex storing prefixes of a particular language. Local activation of a certain point on this patch of neural tissue evokes the patterned flow of spikes directed to the muscles producing vocalization of the prefix. However, we could not apply the same techniques for the roots of words, since the small number of prefixes (about 20) can not describe reliably positions of several thousands of Russian word roots. The thesaurus of roots constitutes the basis of any language and needs specific approach to elucidate its structure. We believe that the accurate mathematical results obtained for other elements of speech imply regular structure of this basic "database" of the language.

#### **MOST FREQUENTLY USED ROOTS**

There are several thousands word roots in any of widespread languages. Most generally accepted unit of speech is the word and just words are usually listed in the dictionaries. Extraction of word root or stemming procedure is sometimes not a simple task especially if the word is not frequently used. For the study of the complete (as possible) set of roots the proper selection of the language is important. The structure of the language, the orthography and the availability of linguistic resources determine the choice. Our experience with the European languages [6] led us to the selection of the German for the detailed study. The kindred Swedish can be used for comparison [7], the orthography is reasonably sound and the data are readily available [8]. We found it even easier to work with the German then with the Russian language [9].

The analysis of the ordered list of German words [8] is the essence of this study. The list conforms the Zipf law [10] - the frequency of occurrence of any word is inversely proportional to the rank of this word. Rank is the position in the list of words with decreasing frequency of occurrence. The list contains words very different in their nature. Top rank words are articles, prepositions and pronouns. There are many personal or geographical names, abbreviations. Quite a few words are evidently borrowed from other languages. We decided to disregard all these words in our analysis. We filtered the ordered list of German words [8] and generated ordered list of German roots which displays dependence very different from the list of words, see Fig.1.



**Fig.1.** Logarithm of the frequency of occurrence of the word roots of German language as a function of the root rank in the ordered list. The dots fuse together to form a continuous black line. The dependence is nearly exponential, though exact formula is:

#### Ln F = $-2 - (R/200) + (R/200)^2/32$ ,

where F is the frequency of occurrence of the word root and R is the rank of the root. The grey line on the plot shows this curve. Prominent deviation for the top rank roots is clearly seen.

The top rank roots are: ver-ein-igen, ver-nicht-en, ist, werd-en, hat, jahr, all-e, sei-n, hab-en, Tag, Mann, wird, war, sind, nehm-en, stell-en, geb-en, neu, mehr, könn-en, ander-e, kenn-en, komm-en, Teil, soll-en, Zeit, halt-en, erst-e, Arbeit, sag-en, weit-ere, gegen, richt-ig, Stand, Land, viel, sprech-en, Fall.The representative roots from the middle of the list, starting with the rank 800 are: Ge-duld, Golf, reiz-en, Pflanz-e, grau, Ge-lenk, Beut-e, schwimm-en, flieh-en, Öl, quer, back-en, Glanz, Erb-e, Ge-schmack, marsch-ieren, Kais-er, Mahl, Tasch-e, Scher-e, ew-ig, egal, Quell-e, Bomb-e, wag-en, Pferd, Eisen, Fleisch, Pfenn-ig, mahn-en, Schirm, wink-en, Witz, Gas-e. One can see prominent deviation from the general dependence for the top rank roots of the list. This contribution falls off very quickly, so that the dependence is exponential on logarithmic scale, see Fig.2.



**Fig.2.** Exponential dependence on the root rank of the deviation of the logarithm of the frequency of occurrence for the top rank roots in Fig.1.

This means that the frequency of occurrence of the word roots in German language is accurately described by the formula:

#### Ln F = $-2 - (R/200) + (R/200)^2/32 + 1,2 \exp(-R/44)$ ,

where F is the frequency of occurrence of the word root and R is the rank of the root.

In contrast with the classic Zipf law for words, where no scale is observed, here we see just two different scales for word roots. Long range with the scale of 200 roots and short range with the scale equal to 44 roots. These features are nearly the same for the less extended database of about 100000 words, we compiled from German classic literature (Schiller, Heine, Goethe, Grimm). This list is about thousand times smaller then the corpus used for the construction of the frequency list of German words [8]. Quite similar results we get from the database [9] for Russian language, as well as from our short database of 100000 words from Russian classic

literature (Pushkin, Lermontov, Gogol, Goncharov, Tolstoy, Chekhov, Sholokhov).

As one can see from Fig.1, the most extended database of German language [8], compiled from several millions of German words, includes about 1800 roots. This can be compared with about 2650 German and 2850 Swedish roots (2050 of which can be considered as the common ones) selected through the scrutiny of dictionaries [7]. This means that even quite large corpora of texts do not include considerable number of roots familiar for an intelligent person. They are stored in the brains of these people (and dictionaries).

Roots differ in their "productivity" and can generate both common and rare words. A single root can form more then hundred different words using affixes or combining with other roots in complex words. This holds for German and Russian and probably, for other languages as well. Other roots may form just a single word. The number of derived words is another specific characteristic of each root in addition to the frequency of occurrence. These two values specify position of each root on the two-dimensional surface. It turns out, that all the roots cover a certain area on this plane in a regular manner. We start the study of this distribution for Russian, Czech and German languages. The results will be published elsewhere. This approach seems to be fruitful for the detailed mathematical comparison of languages, since the complete thesaurus of roots is taken into account. This representation of the basic database of language also can explain the limited number of roots in human language. Most probably, only small patch of cortical surface is genetically allotted for the storage of the most important parts of the words considered basic for the native language. All this is a subject for detailed study, both theoretical and experimental.

## THE CORTICAL REPRESENTATION OF THE ROOTS

The occurrence of words and their roots in the texts, included in the corpora, to some extent reflect their use in everyday speech. Presumably, the vocal system addresses a request to the cortical area storing the "subroutine" of corresponding root of the word to be uttered. The more often this request is sent the more developed is the neural connection between corresponding cortical area and the vocal muscles. This system emerges in early childhood, during acquisition of the mother tongue. The connection is supported by the fibers of the corticobulbar tract, which on the cortical side innervates a certain area of gray matter. The terminals spread in the neural tissue and the characteristic length of the intracortical axons is several millimeters [11]. We can conjecture on the basis of data from other elements of language [3, 4, 5] and present findings, that the cortical representations of roots are

spread more or less evenly in a certain area. The further lies the root from the place where the neural fibers enter the cortex, the less frequently it will be addressed. From the present linguistic data we observe existence of two contributions to the frequency of occurrence of roots or two scales for their cortical representations. It is worth mentioning that there exists the neural object with just this property. That is retina of the eye. Sensitive cells are spread all over its surface, though there is the small place with much higher density of such cells - the fovea. Sure, this is just the prompt for future studies. In general the situation resembles early genetics, when numerical analysis of the variations of traits of fruit fly led to the discovery of uni-dimensional layout of genetic material. We believe that the analysis of combinations of the elements of language can disclose the structure of the cortical layout of language.

Supported by the Grant of the Russian Fund for Basic Research 09-02-12144-ofi\_m.

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# Performance and Quality of Service Analysis over Software-based Firewall Security Architectures

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## ABSTRACT

Although network-based firewalls have been widely implemented in order to deploy a first security barrier within private networks, and several firewallbased security architectures have been proposed, the implementation of firewalls on such architectures produces several benefits and drawbacks that are not taken into account during network security designing procedures. The lack of a firewall-based security management guide can indeed lead the network administrators to implement robust security infrastructures that finally could result in a considerable negative variation on the network efficiency, traffic and *QoS* performance.

The main goal of this paper is to analyze the network performance and quality of service over firewall-secured architectures, by implementing and evaluating real and non-real time services over network scenarios such as screened subnet, dual firewall and dual firewall/dual demilitarized zone.

Performance and quality of service tests were run over the network scenarios in three different stages.

During the first part, a network performance test was made. A file was multiple times ftp-transferred between the different security zones of the firewallbased architectures. In the screened subnet scenario, in fact, two transferences were analyzed: between demilitarized and militarized zones and between demilitarized and *WAN* zones. The dual firewall and dual firewall/dual *DMZ* scenarios were analyzed by executing three ftp-transferences: between demilitarized and militarized zones, between demilitarized and *WAN* zones and between *WAN* and militarized zones. The previously explained set of tests provides an overview of the throughput behavior within the security architectures.

In the second part of the analysis, a quality of service test was run over the firewall-secured architectures. Multiple voice calls were made to a voice over IP server from the same security zones used in the first test. Quality of service levels are obtained by assessing and analyzing certain parameters on the network traffic. On voice over *IP* networks these parameters are well defined: delay, jitter and packet loss.

Finally, a simultaneous performance and quality of service test was achieved. Both ftp-transferences and voice over IP calls were made between the different security zones of the firewall within the network. For this set of tests, quality of service rules were implemented in the firewall in order to create priority queues depending on the service requirements.

The paper presents an analysis of the performance and quality of service results obtained from the tests over the firewall security architectures. The gathered data include performance and quality of service parameters such as throughput, delay, jitter and packet loss. The 14<sup>th</sup> World Multi-Conference on Systemics, Cybernetics and Informatics: WMSCI 2010 June 29th - July 2nd, 2010 – Orlando, Florida, USA

## Study on the method of the Construction of emergency Logistics System based on the national strategies

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**Abstract::** emergency logistics system is a complex large system.Therefore, if we want the emergency logistics system gets better and better, we must build it from the national strategic perspective and consider all levels of emergency logistics and every logistics node to optimize the structure and process of emergency logistics systems.Meanwhile, we should establish not only scientific and standardized safeguard mechanism of emergency logistics but also an efficient operation mechanism of emergency logistics.

Key words: Emergency Logistics; Optimization of Large-scale Systems; National Emergency strategy

### Introduction

Social problems concerning population, resource, environment and public health, etc. are becoming increasingly serious due to the rapid development of modern society, which result in a frequent occurrence of various public emergency events with deterioterated destruction and widespread influence. Natural disasters, public health emergency, catastrophic accidents and many other disasters often lead to chain social reactions and political consequences. Moreover, they can bring about unexpected results which are harmful to the survival and development of human beings. The need to save the lives and property of people, decrease the losses, and provide victims with food, water, clothes, housing, medical care and many other daily necessities in time proves a great challenge for the emergency management, especially the national emergency logistics system of China.

Emergency logistics system is a complex large system, involving government, industry organizations, logistics enterprises at different levels, and different systems of institutions. Besides, it also involves the purchase, storage, transportation, distribution and many other links of various functions and many other elements like information, regulations, talents, theories and so on. Therefore, it is difficult for a single place or organization to deal with major emergencies, which often require the allocation of all the available logistic resources in society from the state's macro-perspective to realize the rescue and protection practices. Therefore, the future emergency logistics system should be built systematically from the national strategic perspective and consider all levels of emergency logistics and every logistics node to optimize the structure and process of emergency logistics systems.

## optimal model of a large-scale system

In this paper, by discussing the establishment of scientific and standardized safeguard mechanism of emergency logistics and the establishment of an efficient operation mechanism of emergency logistics, the author studies the way of emergency logistics construction. Starting with the components, this passage researches and analyzes the basis of emergency logistics system and operating mechanism; from the perspective of national security strategy, the author studies not only how to organize and manage emergency logistics resource, but also the law of its development, characteristics and pattern of operation, as well as establishing the basic framework of the emergency logistics management. This paper also studies the system's goal and its constraints from a functional view, interpret the entire system further, and at last, realizes the reasonable regulation and optimized control of the emergency supplies. By studying the high-intensity dynamic and non-stability

of the structure of emergency supply chain, the author points out that the construction and temporary emergency supply chain restructuring should focus on how to make the supply chain reliable, flexible and research into the method about how to reconstruct the emergency logistics supply chain fast and form the risk management mechanism.

• Emergency logistics is a complicated system.It's difficult to make a scientific description of the scientific decision-made process of emergency logistics' supply in a conventional way of modeling. Based on this ,we try to investigate the emergency logistics support process by using the theory of optimal large-scale systems.The details as follows:



A large-scale system optimal mergency logistics model is an optimizational algorithm system made by coupled multi-layer model , which consists of orthogonal test, goal programming and the "0-1" programming model.It's the relevance of orthogonal test, goal programming and the "0-1" planning, which optimizes and decides by layer.

• on the basis of large-scale system optimal idea, there are three phases to create a analysis model.

First phase, the following object equation will be constructed throught Orthogonal experiment:

## Max $Z=a_1m_1+a_2m_2+a_3m_3+....+$

#### anmn

ai represent a coefficient of object equation which depends on the expert member' grading. Construct the factor and level Figure, set feasible solution's searchable region for programming, speed up the programming optimizing.

Second phase, multiple target programming model. Target function:

$$\min z = \sum_{l=1}^{L} P_l \sum_{k=1}^{K} (\omega_{lk}^{-} d_k^{-} + \omega_{lk}^{+} d_k^{+})$$

constraint condition:

$$\sum_{j=1}^{n} c_{kj} x_{j} + d_{k}^{-} - d_{k}^{+} = g_{k}, \quad k = 1, L, K$$

$$\sum_{j=1}^{n} a_{ij} x_{j} \le (=, \ge) b_{i}, \quad i = 1, L, m$$

$$x_{j} \ge 0, \quad j = 1, L, n$$

$$d_{k}^{-}, d_{k}^{+} \ge 0, \quad k = 1, 2, 3$$

Algorithm is as follows:

(1)Establish the initial simplex tableau, the number of rows in the table will be tested by the number of priority factors were fitted to K-line, set k = 1(2)Check the line for the presence of a negative, and the corresponding line of the first k-1 coefficient is zero. If negative, take the least of which corresponds to the variable into the variable for the exchange, transfer (3). If not negative, then turn (5). (3)Minimum ratio of the rules by changing the variables, when there is two or more same minimum ratio, select high-priority variable for the variable (4) do the basic transformation operations in simplex algorithm way, create a new calculator, return (2). (5) When k = K, the calculation is ended. Solution of the table shall be satisfactory solution. Otherwise, set k = k + 1, return to (2).

Third phase,0-1 programming model Target function:

$$Max \ Z = c_1 x_1 + c_2 x_2 + L + c_n x_n$$
  
constraint condition:  
$$\sum_{i=1}^{n} a_{ij} x_j \le (or =, or \ge) b_i \quad (i = 1, 2, L, m)$$

The third phase, using genetic algorithms.

(1)Coding towards solving the issue;

(2) random initial population X(0) := (x1, x2, ..., xn);

(3) to the current population X (t) xi for each individual, calculate the fitness F (xi), the fitness of the individual function indicates it good or bad;

(4) application of the selection operator produces the middle generation of Xr (t);

(5) on Xr (t) Application of other operators, come to the next generation of group X (t + 1), these operators aim is to extend the limited coverage of the individual, embodied the idea of global search;

(6) t: = t +1; if the termination does not meet the conditions, continue (3)

• The whole process is as shown:



 large-scale system optimal emergency logistics modeling

On the basis of large-scale system optimal theory, we can regard the goods as decision variable ,because the goods is our target.

So, we must number the goods, define the goods i to Xi, it constructs a decision variable that we need form X1 to Xi.

In the first constraint equation, we can regard the gross goods as target constraint. And the sum of every goods ought to be more than the gross remands, the vivid express equation is :

a11\*X1+a12\*X2+a13\*X1+a14\*X4+a15\*X5+a16\*X6 >=TotalObj

As have been defined ahead, alj(j=1,2,3,4,5,6) represent every weight of every goods, Xi(j=1,2,3,4,5,6) represent the goods type. TotalObj represent the gross weight of all goods.

According the second constraint equation, the time of completing all the good's carry would be less than a wish time.

a21\*X1+a22\*X2+a23\*X1+a24\*X4+a25\*X5+a26\*X6 <=TimeLimit

A2j(j=1,2,3,4,5,6) represent the time of goods through air cargo, otherwise, we need to take account for the selection of

different Vehicles that need different workers and equipment.

a31\*X1+a32\*X2+a33\*X1+a34\*X4+a35\*X5+a36\*X6 <=MachineLimit

a41\*X1+a42\*X2+a43\*X1+a44\*X4+a45\*X5+a46\*X6 <=PeopleLimit

At the same time, we must take over the practice benefit of every goods, we want the benefit to be maximized.

#### a51\*X1+a52\*X2+a53\*X1+a54\*X4+a55\*X5+a56\*X6 >=Maxprofit

Aij(i=11) (j=1,2,3,4,5,6) represent the benefit of every good's transport. We wish to maximize the gross practice benefit what the goods through transport. Transportation of every goods needs to some cost, we want the benefit to be minimized.

a61\*X1+a62\*X2+a63\*X1+a64\*X4+a65\*X5+a66\*X6 <=Plough

Constraint equation Safety coefficient:

#### a71\*X1+a72\*X2+a73\*X1+a74\*X4+a75\*X5+a76\*X6 >=Risk;

**Decision variable** 

| Num | Code | Name    | Unit | Notes |
|-----|------|---------|------|-------|
| 1   | X1   | Goods1  | Ton  |       |
| 2   | X2   | Goods2  | Ton  |       |
| 3   | X3   | Goods 3 | num  |       |
| 4   | X4   | Goods 4 | Ton  |       |
| 5   | X5   | Goods 5 | num  |       |
| 6   | X6   | Goods 6 | Ton  |       |

Constrain variable

| Num | Code | Name         | constraint         | Notes |
|-----|------|--------------|--------------------|-------|
| 1   | Y1   | TotalObj     | Goal<br>constraint |       |
| 2   | Y2   | TimeLimit    | Goal<br>constraint |       |
| 3   | ¥3   | MachineLimit | Goal<br>constraint |       |
| 4   | Y4   | PeopleLimit  | Goal<br>constraint |       |
| 5   | ¥5   | Plough       | Goal<br>constraint |       |
| 6   | ¥6   | Maxprofit    | Goal<br>constraint |       |
| 7   | Y7   | Risk         | Goal constraint    |       |

We can express the gross object: Max Z= Wi\*TotalObj+ Wi \*(-1) TimeLimit+ Wi \*(-1) MachineLimit + Wi \*(-1) PeopleLimit+ Wi \*Maxprofit+ Wi \*(-1)Plough+Wi\* Risk;

**Constraint equation** 

| Varia<br>ble | Constraint equation   | Notes |
|--------------|---|-------|
| Y1           | a11*X1+a12*X2+a13*X4+<br>a14*X4+a15*X5+a16*X6>=TotalObj         |       |
| Y2           | a21*X1+a22*X2+a23*X1+<br>a24*X4+a25*X5+a26*X6<=TimeLimit        |       |
| ¥3           | a31*X1+a32*X2+a33*X1+<br>a34*X4+a35*X5+a36*X6<=MachineLi<br>mit |       |
| Y4           | a41*X1+a42*X2+a43*X1+<br>a44*X4+a45*X5+a46*X6<=PeopleLimi<br>t  |       |
| Y5           | a51*X1+a52*X2+a53*X1+<br>a54*X4+a55*X5+a56*X6>=Maxprofit        |       |
| ¥6           | a61*X1+a62*X2+a63*X1+<br>a64*X4+a65*X5+a66*X6<=Plough           |       |
| Y7           | a71*X1+a72*X2+a73*X1+<br>a74*X4+a75*X5+a76*X6>=Risk             |       |

Wi represent the coefficient of every constraint equation's importance, this coefficient of weight is defined by the expert system.

The model of the object programming has been created, and it can calculate the every Xi through object programming if we give some true data, and can get the quantity, transport time, personnel allocation, equipment allocation and satety of every goods if multiply the relevant coefficient.

#### 0-1 programming model

Target function: Max Z= Wi\*TotalObj+ Wi \*(-1) TimeLimit+ Wi \*(-1) MachineLimit+ Wi \*(-1) PeopleLimit+ Wi \*Maxprofit+ Wi \*(-1)Plough+Wi\* RiskValue;Wi (i=1,2,3...N) Was the subobject weight come from the expert system.

Decision variable

| number | code | name     | unit | note |
|--------|------|----------|------|------|
| 1      | X1   | Goods1   |      |      |
| 2      | X2   | Goods 2  |      |      |
| 3      | X3   | Goods 3  |      |      |
| 4      | X4   | Goods 4  |      |      |
| 5      | X5   | Goods 5  |      |      |
| 6      | X6   | Goods 6  |      |      |
| 7      | X7   | Goods 7  |      |      |
| 8      | X8   | Goods 8  |      |      |
| 9      | X9   | Goods 9  |      |      |
| 10     | X10  | Goods 10 |      |      |

| <b>a</b> | •     |        |   |
|----------|-------|--------|---|
| Constra  | ant v | ariabl | e |

| num | cod | name              | unit   | Constr |
|-----|-----|-------------------|--------|--------|
|     | e   |                   |        | aint   |
|     |     |                   |        | symbo  |
|     |     |                   |        | 1      |
| 1   | Y1  | PerObjTotal       | ton    | <=     |
| 2   | Y2  | PerObjMachineLim  | num    | <=     |
|     |     | it                |        |        |
| 3   | ¥3  | PerObjTimeLimit   | hour   | <=     |
| 4   | Y4  | PerObjPeopleLimit | person | <=     |
| 5   | Y5  | PerObjPlough      | RMB    | <=     |
|     |     |                   | yuan   |        |
| 6   | Y6  | PerObjMaxprofit   |        | >=     |
| 7   | Y7  | PerObjRisk        |        | >=     |

| Constraint | equation   |           |
|------------|--|-----------|
| variable   | straint equation   | notes     |
|            |  |           |
| X/1        | - 11 * V1 - 10 * V0 - 10 * V4 -                              | T         |
| Y I        | $a11^{*}X1+a12^{*}X2+a13^{*}X4+$                             | Limit to  |
|            | a14*X4+a15*X5+a16*X6+  | demands   |
|            | a1/*X/+a18*X8+ a19*X9+                                       |           |
|            | all0*X10>=Obj1otal   |           |
| ¥2         | a21*X1+a22*X2+a23*X4+  | Limit to  |
|            | a14*X4+a25*X5+a26*X6+  | transport |
|            | a27*X7+a28*X8+ a29*X9+                                       | equipment |
|            | a210*X10= <machinelimit< td=""><td></td></machinelimit<>     |           |
| Y3         | a31*X1+a32*X2+a33*X4+  | Limit to  |
|            | a34*X4+a35*X5+a36*X6+  | transport |
|            | a37*X7+a38*X8+ a39*X9+                                       | time      |
|            | a310*X10= <timelimit< td=""><td></td></timelimit<>           |           |
| Y4         | a41*X1+a42*X2+a43*X4+  | limit to  |
|            | a44*X4+a45*X5+a46*X6+  | the       |
|            | a47*X7+a48*X8+ a49*X9+                                       | transport |
|            | a410*X10= <peoplelimit< td=""><td>people</td></peoplelimit<> | people    |
| Y5         | a51*X1+a52*X2+a53*X4+  | Limit to  |
|            | a54*X4+a55*X5+a56*X6+  | the costs |
|            | a57*X7+a58*X8+ a59*X9+                                       |           |
|            | a510*X10= <plough< td=""><td></td></plough<>                 |           |
| Y6         | a61*X1+a62*X2+a63*X4+  | Benefit   |
| -          | a64*X4+a65*X5+a66*X6+  | maximize  |
|            | a67*X7+a68*X8+ a69*X9+                                       |           |
|            | a610*X10>=Maxprofit  |           |
| ¥7         | a71*X1+a72*X2+a73*X4+  | Limit to  |
| - '        | a74*X4+a75*X5+a76*X6+  | satety    |
|            | a77*X7+a78*X8+ a79*X9+                                       | Succey    |
|            | a710*X10>-Risk   |           |
|            | a/10/A10>-KISK   |           |

#### Conclusions

Emergency logistics system is a complex systematic project. If it concludes too much, and the project will improve a difficulty and the quality of construction will not be guaranteed. Therefore, we must study and analyze the current emphasis of construction .The most important thing is to make breakthroughs in key projects. Consequently, the construction of emergency logistics system will be stimulated and promoted.

First of all, we should optimize the design of the the scale, variety, structure, etc. of emergency supplies from the overall strategic perspective. Based on different types of public emergencies and different intensity, potential demand and the importance of the
materials, experts on emergency management organized by national emergency supplies safeguard departments study and demonstrate the type, name, function and way of stowage of emergency supplies at four levels, the country, the army, the market and the family, and so on, and build emergency supplies information systems and realize the aggregation of the information of various types of emergency supplies and the forecasting of potential demand.

Second, we should strengthen the management of emergency supplies for reserves. On the one hand, we should demonstrate and plan the proportion of emergency supplies physical reserves, production capacity savings, technical reserves and funding reserves in a scientific way. On the other hand, it's important to optimize and adjust the layout and structure of emergency supplies of all professions and at all levels. Make sure that the numbers, the sizes, and the models of emergency supplies for reserves are reasonable, so that we can combine dispersed reserves with concentrated reserves, make full use of social potential and build emergency supplies reserve system of Chinese characteristic which makes the country, the military, the districts, the markets, and families an integral whole. In particular, in order to make sure that the emergency supplies are sufficient, efficient and reliable, we should strengthen the management of reserve materials in the storage and establish a standard, maintainable updating mechanism. Only in this way can it meet the demand to deal with public emergencies.

Third, form diversified ways to raise emergency supplies .By making full use of various financing methods, we can establish emergency material reserves of reasonable layout, proper size and optimized structure. What's more, it can not only improve the mechanism for mobilization and acquisition of emergency supplies, emergency production mechanism and emergency purchasing mechanism, but also mobilize the enthusiasm of international aid and social contributions, which will form a wide range of emergency response material financing channels to ensure the timeliness, reliability, regularity and safety of the financing of emergency supplies.

Finally, we should form stereoscopic and reticular channels for emergency supplies. We must improve the supporting facilities of highway, aviation and many other areas, upgrade the service and security ability of the facilities concerning airports, terminals, highway service areas. On the one hand, we should improve the substitutability and mobility of railway, highway, aviation and other ways of transporting, as well as putting ways of transportation together and unifying standards about transportation. On the other hand, taking into consideration the existing foundation of railways, highways, waterways, aviation and other ways of transportation, we can establish the emergency logistics "green channel" mechanism to ensure that the emergency logistics channel is always smooth.

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### Information System Using Knowledge Background

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#### ABSTRACT

The project "Knowledge Management of the Czech Armed Forces (CAF) Network Enabled Capability (NEC)" is the first research project dealing with the problems of knowledge acquisition, processing, and their use in the Czech military. The project started with analysis of the knowledge approaches and tools that could support information systems (IS). The main goal of the project is to suggest an IS with knowledge background. The solution principles and methodology are described. The basic terms are depicted. Topic Maps (TM), the theoretical base of the solution, are explained; ideas of the IS are mentioned, and proposed methodology is described. The prepared system should support the organization of information, the knowledge acquisition, processing, and using. The core problem is to suggest a proper ontology that is an enter point by approach to documents of the IS.

**Keywords:** Knowledge, information system, ontology, Topic Maps, methodology.

#### **1. INTRODUCTION**

The aim of the Research Project "Knowledge Management of the Czech armed Forces (CAF) Network Enabled Capability (NEC) - MENTAL" [1] is "To carry out the analysis of knowledge approaches, ontologies and ontology languages, and to assess their suitability for using them in the Information System (IS) development"

The accomplishment of the project is assured by successful cooperation of researchers from the University of Defence with the industry by implementing commercial technology.

NEC is a new military strategy with keeping warfare activities in the networking environment, achieving the information and decision support superiority.

# 2. TOPIC MAPS – THE THEORETICAL BASE OF THE SYSTEM

The main reason using Topic Maps (TM) is that knowledge representation is intuitive; it keeps information in context, and conforms to human thinking more than other knowledge organization principles. The TM model consists of the three basic elements: topic, association between topics, and occurrences of the topics.

**Topic Maps** are standardized in ISO/IEC 13250:2003. The new promising development possibilities of the TM include filtering by scopes, TM merging and Topic Map Query Language.

**The Topic** contains denominated subject of interest. It stands for a subject we want to discuss; it is its substitute in the computer. Each topic represents just one subject. It is a place in Topic Maps where all known information on the given subject is available by means of relations and occurrences.

**Subject** is a part of the real world, which is described in a Topic Map. Each subject is represented by one topic in a Topic map and it can be anything: a person, thing, entity, process, etc. The subject is unambiguously addressed by identifiers:

- Subject Locator for information sources.
- Subject Identifier for other subjects.

**Subject Locator** stands for the subject; it is an information source accessible in a computer system, it is addressable in URL (Uniform Resource Locator).

Associations represent relationships between topics, are bidirectional, and express relationship between subjects; they are not oriented and may have an arbitrary form.

**Occurrences** are formed by information relevant to a given topic; they can refer to information or they might just contain it. There are two types of occurrences:

- 1. Internal occurrence that represents the topic characteristics and is placed directly in the Topic Map.
- 2. External occurrence as a reference to an external information source. It connects the information and the knowledge layers.

# 3. FUNCTIONS OF THE INFORMATION SYSTEM

The system is supposed to support the management of information sources, development of the knowledge



Figure 1: Technological architecture of the IS

base, recording of the outcomes of the NEC building in the CAF and deduction of findings for decision support in the CAF.

The full text server will enable retrieving information from heterogeneous information sources in a unified way. The full text server will be connected to selected information sources on the NEC using gateways and spiders. Gathered pieces of information will be normalized using filters and indexed. This will make the content searchable and ready for the full text analysis.

Tools for full text analysis and visualization will be used to analyze the content of information sources. The tool for content analysis will enable to find key concepts in the large content. The tool for context analysis will aid organizing pieces of information related to the selected concepts. The result of full text analysis will be the knowledge map describing key concepts and relations between them as well as related information resources.

The important part of the knowledge map will be "dynamic occurrences" – a full text queries that will allow users of to find resources related to NEC key concepts. These queries will be also used for automated categorization of the information assets by the full text server. The Knowledge Map created using analytical tools will be the basis of the knowledge base, where will be the knowledge map stored in the Topic Maps format, managed and updated. The TM format is very suitable for this case, as it is tailored for describing concepts, relations between them and related information resources. TM also enables to combine pieces of the knowledge map easily and to define faceted views for different users and groups.

The WEBnet CMS knowledge portal will enable users to navigate through the knowledge base and to insert dynamic occurrences represented by structured queries. The .NET Client Knowledge Portal will enable users to search information, and to browse information resources related to key NEC concepts. This will enable users of the system to see all available information about NEC in the context. The context helps users to deduce findings for the decision support.

# 4. THE ARCHITECTURE OF THE SYSTEM

It is supposed that for the development of CAF NEC Information System technological architecture is to be employed. It includes several component parts (Fig. 1).

**WEBnet CMS** is a complex system for content management. It is based on a document which is built into a topic tree; it can be in knowledge base. It operates in client/server mode; web browser is the client.

**Tovek Server** is an application for processing a large number of unstructured data; it offers unified approach to miscellaneous data sources. Its functions include indexing, searching and categorizing.

**Tovek Tools** are a set of client applications for carrying out analyses and providing outlines. Its application includes Index manager, Tovek Agent, InfoRating, Query Editor, and Tovek Harvester.

**i2 Analyst's Notebook** facilitates visual data analysis, including net analysis and, consequently, the presentation of outcomes which are mainly in the form of diagrams and charts.

**AToM** is an application which produces knowledge deposit created and organized in line with Topic Maps standard. It facilitates knowledge base creation management and development.

**WEBnet Knowledge Portal** is a presentation layer of the IS content. It enables users to see information in the

context. It solves the user administration and interconnection with other knowledge bases.

**.NET Client Knowledge Portal** is a presentation web layer connected to Tovek Server. It enables common users to retrieve information from information sources. It also enables users to navigate through the content of information using categorization trees / taxonomies generated from knowledge base held in AToM.

# 5. LIFECYCLE OF THE SYSTEM DEVELOPMENT

Proposed methodology will be tested in the project and could await any changes or corrections of the lifecycle steps. Lifecycle of the CAF IS consists of following stages:

- 1. Ideas forming.
- 2. Requirements definition.
- 3. Architecture design.
- 4. Ontology development.
- 5. Data conversion and content creation.
- 6. System implementation.
- 7. System testing.
- 8. User feedback management.

#### 5.1 Ideas forming

This section collects ideas what the IS should be about and how it should work. For more transparency is the section divided in 3 parts.

1) Terminology unification: Achievement the same level of understanding of problem domain by various users is the common problem in knowledge systems. Education the team members in knowledge management is organized. Currently used terms describing the NEC problem domain will be gathered by our experts; the relevant set of source documents will be defined.

Results will be maintained as a controlled vocabulary according wide used multilingual thesauri standards (ISO 5964); converted them to TM is one of essential parts of the ontology managed by TM engine (AToM). "Living" terminology with ability of reflection on changes in new resources will be the result.

The multilingual thesauri will support hierarchies of terms (parent-child relations); base names and alias names; terms definitions, where all terms base + alias names and their definitions could exist in various languages; establishment of symmetric links between terms.

**2) Encyclopedia of the NEC terms preparation:** This part represents further enhancement of the terminology (based on multilingual thesauri standards) to more complete ontology targeted on end-user:

- New topic types will be created, new associations (based on TM principles) between terms will be established.
- New properties and occurrences to external information resources will be setting up.

Comprehensive editorial system for management all this stuff by adding and maintaining instances of topic types, occurrences, associations, properties by the team of editors will be initialized:

- Ontology will be maintained by internal domain experts only.
- Instances can be created and maintained by both by internal and external users equipped with proper editorial rights.

The comprehensive knowledge and information solution as a source for the web portal will be a result.

**3)** Knowledge based web portal with the features forming: Register view based on topic types (1 topic type = 1 register view). Full text search capabilities will be introduced; at first in topic map; at second in unstructured content, and browsing in TM; topic view for topic details including all occurrences and associations.

"Anonymous" functionality for not registered users is available; personalized functionality for registered users; up-to-date web design; new topics view, random topic view, most displayed topics view; administration interface for controlling the system behavior.

#### 5.2 Requirements definition

Full text indexation of the new resources without control is assigned; handling with indexed metadata (variability of indexes); wide analytical possibilities of the indexed content. Automated monitoring of information resources; once relevant information is included (e.g. document with terms which are matters of concern); editors should be notified or alerted.

Import new instances of ontology classes (topic instances, occurrences, associations) by batch processing; comfort maintaining instances of ontology classes manually by editors; openness for ontology modifications with no necessity to re-code web portal applications; complete and secure accessibility of the editors via internet.

#### 5.3 Architecture design

Ontology building and system maintenance is the next step; internal interface for ontology designer (editor with special rights); controlled content management system (instances of classes) – web based interface for editors.

Unstructured content research system – interfaces to analytical tools for editors accessible via internet (terminal connection) and browsing and retrieval the system – web interface for end-users.

#### **5.4 Ontology development**

Methodology of the ontology development is depicted in Figure 2; in this figure we can recognize that ontology development is formed mainly thru iteration processes. These iteration processes should be always verified by the reality and the mature methodology for ontology preparation of the CAF will be one of the final project results.



Figure 2: Ontology development steps

#### 5.5 Data conversion, and content creation

This stage also covers content creation - that means establishing, editing, and finalizing all documents; instances of classes creation – using TM methods and routines; this means topic types, associations, occurrences, roles, names, scopes.

#### 5.6 System implementation

Establishment of all kinds of interfaces to match goals, requirements and architecture design described in 5.1 - 5.3 stages. Due to rational management of the system infrastructure (servers, operating systems, database software), the system will be partly outsourced by project partners.

#### 5.7 System testing

Due to novelty of the system, the verification of all project parts and parameters is strongly recommended (usability, correctness, and benchmark). The successful testing phase of the project must be accepted before launching project to end-users.

#### 5.8 User feedback management

User satisfaction will be permanently monitored to ensure that the system fulfils the end-users requirements and needs. The feedback will be monitored using E-mail or personal discussion, because the foreseen number of users is quite small.

#### **6. CONCLUSION**

The development of the Information System with knowledge background is at its starting point. Nevertheless, the research team has managed prerequisites for its successful creation. Particularly, a number of basic information has been collected, the preparation of researchers has been commenced and the conception solution has been designed.

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# System Modelling of Benchmarking Flexibility of a Service Supply Chain: A SAP-LAP hills Framework

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# ABSTRACT

# 2. SERVICE SUPPLY CHAIN MANAGEMENT

The purpose of this ongoing research is to have an insight on the change management activities in a safety, health, environment and risk (SHER) service supply chain. In this regard, a new change management model named 'SAP-LAP hills' has been presented. An attempt to benchmark the changes has been made and an index named SAP-LAP index of change has been proposed. Based on the intensity of change, the change forces were distilled as (i) Still, (ii) Breeze, (iii) Wind and (iv) Storm. The paper is concluded with managerial implications and scope for future research.

Keywords: SHER, SAP-LAP hills, Service logistics, SAP-LAP Index.

# **1. INTRODUCTION**

Organizations have to adopt an appropriate change management for long-term survival and sustainability. Service sectors are getting more and more popularity in the current industrial scenario and service logistics has become a hot topic for discussion also. In this milieu, this research is an endeavour to know more and more about the strategies to be adopted for increasing the core competence of service organizations (Senge. et al.. 1994). SAP-LAP framework gives a glimpse in that direction

SCM concerns with an effective approach to coordinate the various links in the entire chain by both improving the customer services and lowering the cost.

In this contemporary scenario, trends of servetization gave rise to the adoption of SCM principles in service sectors. A service supply chain involves the series of activities from the analysis of customer need, service design to service delivery. A road map of a general service supply chain is shown in Figure 1.

# 2. SAP-LAP FRAMEWORK

In SAP-LAP analysis. situations represent all demographics. Situations are changing in a totally unexpected manner (Sushil, 1997). Actors are the major stakeholders involved in the situation. Processes are the mechanism to convert the input into output. Learning represents the key-learning phase of SAP. Action represents the action which has to be taken in such a way that outcome outperforms the situation in a better way. The performance is the expected output (Sushil, 2001).

# **3. ABOUT THE COMPANY**

The company EFG began its operation in 1986 and has grown to become one of the world's leading organizations for the provision of safety service to industry. With bases in Europe, North America and Asia, EFG group provides a truly global coverage. Their Indian specialists based in Mumbai and other places, provide a focal point of expertise in India/Asia through which their clients have assess to full range of expertise and state-of-art laboratory facilities which makeup the EFG group. The current turnover of EFG is 80 million USD (Whole) and INR 5 Crores in India. The number of employees is 180 (Whole) 25 (India).

# 4 SAP LAP FRAMEWORK FORMATION

At the outset, 12 situations occurred in 2007-January to 2008 August were considered for study (Pramod and Banwet, 2010).

 $1^{st}$  Situation (S<sub>1</sub>)-(January 2007):

Company decided to expand business to some more locations

 $2^{nd}$  Situation (S<sub>2</sub>) - (March 2007): New hiring of employees as the business is expanding

 $3^{rd}$  Situation (S<sub>3</sub>) - (April

2007):Introduce training programme to customers

 $4^{\text{th}}$  Situation (S<sub>4</sub>) - (May

2007):Customers are demanding training programmes and small services before availing their major services

 $5^{\text{th}}$  Situation (S<sub>5</sub>) - (Oct 2007):

Requirement of outside expertise

 $6^{th}$  Situation (S<sub>6</sub>) - (Nov 2007): Unexpected resignation of some executives

7<sup>th</sup> Situation (S<sub>7</sub>) - (Jan 2008): Sudden increase of demand of safety related consultancy

 $8^{th}$  Situation (S<sub>8</sub>) - (Feb 2008): Use of a new risk assessment software

 $9^{\text{th}}$  Situation (S<sub>9</sub>) - (March 2008):

Introducing employee performance appraisal scheme

 $10^{\tilde{t} h}$  Situation (S<sub>10</sub>) - (March 2008): Emergence of competitors 11<sup>th</sup> Situation  $(S_{11})$  - (June 2008): Unexpected enquiries from new clients 12<sup>th</sup> Situation $(S_{12})$  - (Aug 2008):Company observe lack of coordination of various offices **Actors** The following actors were involved in these situations. A<sub>r1</sub>. Director; A<sub>r2</sub>.Vice president (Technical); A<sub>r3</sub>.GM (Marketing); A<sub>r4</sub> Manager (HRD); A<sub>r5</sub>. Technical team; A<sub>r6</sub>. CEO; A<sub>r7</sub>. Competitor **Process** P<sub>r1</sub> - Do the market research for business opportunities

 $P_{r2}$  - Acquiring land for the

establishment of office at Chennai (India)

 $P_{r3}$  . Opening of New branch in Chennai  $P_{r4}$  . Advertise the vacancies in internet

and news papers

- $P_{r5}\ \ Started$  customer contact programmes and presentation
- $P_{r6}\ _{\text{-}}$  Providing customer service and
- training on the basis of client request

 $P_{r7}\,$  - Search for externals for improving training

 $P_{r8}$  . Identification of credentials of trainers and team finalization

 $P_{r9}\xspace$  . Searching another suitable personnel for the same posts

 $P_{r10}$  - Allocation of different projects to technical team

 $P_{r11}$ . Training to the technical staff for understanding new technology

 $P_{r12}$  - Review of their key process areas and appraisals

 $P_{r13}$  . To find out the strength and weakness of competitor

P<sub>r14</sub> Try to solve client enquiries by taking help of senior experts

 $P_{r15}$  . Find out the exact root cause for this problem

After that the learning, action and performance for each cases are

enumerated. They are also shown in Table 1

## Actor-Process matrix

It is a metrics of SAP-LAP analysis in which 'Processes' are shown horizontally and 'Actors' are shown vertically. The situations, learning, actions and performances are posted inside the metrics. The Actor-Process matrix of ABC is shown in Table 2.

# **Prioritized Actor-Process matrix**

This brings out those actors and processes which are really significant to the change management. MD and Technical manager have been requested to prioritize the situations, leaning, actions and performances in the scale of 1-10. It was done by brainstorming ten various executives holding various functions. The figures were added. The sum is shown in prioritized actor-process matrices. The leading actors were 'Director' (Ar<sub>1</sub>) and 'Vice president' (Technical)  $(Ar_2)$  and the process is 'advertise the vacancies in internet and news papers'. The maximum score was 54. The values corresponding to each actor and process were pictorially represented in Figure 2.

# Classification based on the intensity of change

Based on the intensity of change, the change forces can be classified as (i). Stills (ii). Breeze (iii) Winds and (iv) Storms. The region in the first  ${}^{1}/{}_{4}^{\text{th}}$ , where the change forces are minimum is the 'still' region. No cell in the current study belongs to this category. The second  ${}^{1}/{}_{4}^{\text{th}}$ , where the change forces are moderate is the 'breeze' region. The region in the third  ${}^{1}/{}_{4}^{\text{th}}$ , where the change forces are intense is the 'wind' region. The region in the top  ${}^{1}/{}_{4}^{\text{th}}$ , where the change forces are intense is

extremely high is the 'storm' region. They are detailed in Table 3.

# **SAP-LAP Index of change**

This is a quantified index showing the strength of change forces in the organization. The ratio between the sums of the change indices to the sum of the change intensity at the extreme situation is given by a quantified term named as SAP-LAP Index of change. In the current study, SAP-LAP Index of change is 16.

|                  | n                                  |
|------------------|------------------------------------|
| SAP-LAP Index of | $\sum$ Change forces in cell X 100 |
| change =         | i=1                                |
|                  | Maximum Change X Number of         |
|                  | Cells                              |

It is possible to classify the change forces in to four regions based on SAP-LAP Index of change. This helps to utilize SAP-LAP index of change as an instrument for condition monitoring. It is shown in Figure 3. In the current study, the SAP-LAP index of change is 16. This lies in the second region, where care has to be taken.

# **5. MANAGERIALIMPLICATION**

The major contribution of this research is the development of SAPLAP hills, and the SAP-LAP index of change which is an ideal reference point for managers. Instead of adopting strategies by intuitions and past experience, a systematic procedure is illustrated by SAP-LAP hills. As picture worth thousand times an explanation, a detailed three dimensional figure of change is shown in this paper. During the paradigm shift of technology adoption and the rapid trends of virtualization, such an analysis is extremely significant.

## 6. CONCLUSIONS AND SCOPE FOR FUTURE RESEARCH

By means of structured flexibility analysis named as SAP-LAP, it has become possible to have a glance on various situations, actors, processes, learning Actions and performance. The main actors 'Director'  $(Ar_1)$  and 'Vice president (Technical)' (Ar2) and the process is 'advertise the vacancies in internet and news papers'  $(\mathbf{Pr}_4)$ . Therefore, organization has to give highest priority in those dimensions. The actor-process metrics, quantification and SAP-LAP hills helped to locate the key result areas. In the current study, the interdependencies among the elements in the Actor-Process matrix have not been taken into account. As a future scope, the interdependencies can be taken into account and a detailed analysis may be done.

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Figure 2.SAP-LAP hills Considering Weightages

| Table 1 | . SAP | LAP | Table | for | company | EFG |
|---------|-------|-----|-------|-----|---------|-----|
|---------|-------|-----|-------|-----|---------|-----|

| S     | Α               | Р               | L                                      | Α                                 | Р   |
|-------|-----------------|-----------------|--|-----------------------------------|---|
| $S_1$ | A <sub>r1</sub> | P <sub>r1</sub> | Knowledge about Chennai and            | Appointing a marketing manager    | New business opportunities(P <sub>1.1</sub> ) |
|       | A <sub>r2</sub> | P <sub>r2</sub> | demographical variables has to be      | having good familiarity of        | Good client base( $P_{1,2}$ )                 |
|       | A <sub>r3</sub> | P <sub>r3</sub> | taken into account (L <sub>1</sub> )   | Chennai(A <sub>1</sub> )          |   |
| $S_2$ | A <sub>r1</sub> | P <sub>r4</sub> | Analysis of desired profiles and job   | Recruitment of new profile        | Recruitment process ending with               |
|       | A <sub>r2</sub> |                 | recruitment has to be done $(L_{2,1})$ | employees(A <sub>2.1</sub> )      | placement of suitable candidate               |
|       | A <sub>r4</sub> |                 | Knowledge about the manpower           | Hiring employment consultants for | (P <sub>2</sub> )                             |
|       |                 |                 | available in the market $(L_6)$        | searching suitable candidates     |   |

|                        |   |                                    | Employment consultants can give suitable candidate in short time( $L_{2,2}$ )  | (A <sub>2.2</sub> )   |  |
|------------------------|---|------------------------------------|--|---|--|
| <b>S</b> <sub>3</sub>  | A <sub>r5</sub>   | P <sub>r5</sub>                    | Identification of clients requirements is essential( $L_5$ )   | Modification of the programme as<br>per the current customer needs<br>(A <sub>3</sub> )                         | Good feedback from clients<br>and participants (P <sub>3</sub> )                           |
| <b>S</b> <sub>4</sub>  | A <sub>r5</sub>   | P <sub>r6</sub>                    | Training team having good<br>knowledge about the subjects should<br>be deputed (L <sub>4</sub> )   | Refinement of the training package (A <sub>2</sub> )  | Better<br>customer satisfaction<br>(P <sub>4</sub> )                                       |
| S.                     | Δ.  | P <sub>r7</sub><br>P <sub>o</sub>  | Enrichment of knowledge of existing  | Training employees of EFG   | Enhancement of training $(\mathbf{P}_{r})$   |
| <b>S</b> <sub>6</sub>  | A <sub>r1</sub><br>A <sub>r2</sub>                                  | P <sub>r9</sub><br>P <sub>r4</sub> | Knowledge about the manpower<br>available in the market( $L_6$ )<br>Analysis of desired profiles and job<br>recruitment has to be done( $L_{2,1}$ )<br>Employment consultants can give | Recruitment of new<br>executives(A <sub>6.1</sub> )<br>Placement Consultants<br>involvement (A <sub>6.2</sub> ) | Selection of suitable executives $(P_6)$   |
| 6                      |   | D                                  | Appropriate candidate(L <sub>2.2</sub> )   | Company omphasis more on sefety   | Completion of ich within acroad  |
| 37                     | A <sub>r2</sub><br>A <sub>r5</sub>                                  | 1 r10                              | exposure to executives has to be<br>benchmarked( $L_7$ )   | related consultancy(A <sub>7</sub> )  | time limits and good feedback form client( $P_7$ )   |
| <b>S</b> <sub>8</sub>  | A <sub>r2</sub><br>A <sub>r5</sub>                                  | P <sub>r11</sub>                   | There should be motivation for people to learn new technology( $L_8$ )   | Resource allocation for fulfilling the requirement $(A_8)$  | Successful use of the software $(P_8)$   |
| S9                     | A <sub>r2</sub><br>A <sub>r4</sub>                                  | P <sub>r12</sub>                   | Active involvement of top<br>management is required for<br>performance evaluation( $L_{9,1}$ )<br>Employees have to be motivated<br>based on performance ( $L_{9,2}$ )                 | Installation of a good HR policy<br>(A <sub>9</sub> )   | Development of soft<br>and hard skills, leadership and<br>team effort (P <sub>9</sub> )    |
| S <sub>10</sub>        | $\begin{array}{c} A_{r6} \\ A_{r1} \\ A_{r2} \\ A_{r7} \end{array}$ | P <sub>r13</sub>                   | Adoption of proper benchmarking<br>schemes for competitive<br>performance gives better results( $L_{10}$ )   | Analysis of client feedback on<br>performance related issues and<br>compare with competitors $(A_{10})$         | Formation of a good roadmap for<br>increasing the strength of the<br>company $EFG(P_{10})$ |
| <b>S</b> <sub>11</sub> | A <sub>r5</sub>   | P <sub>r14</sub>                   | Adequate knowledge about the subject is required for responding to the enquiries $(L_{11})$  | Initiating additional efforts to satisfy the client enquiry(A <sub>11</sub> )                                   | Job achievement (P <sub>11</sub> )   |
| <b>S</b> <sub>12</sub> | A <sub>r2</sub>   | P <sub>r15</sub>                   | Experience for trouble shooting $(L_{12})$   | Relocation of good managers to control the situation $(A_{12})$   | Cordial relation<br>(P <sub>12</sub> )   |

| Та | ble 2. A | Actor- | Proces | s metric | es with | n the e | estima | ted w | eightag | ges |
|----|----------|--------|--------|----------|---------|---------|--------|-------|---------|-----|
|    |          |        |        |          |         |         |        |       |         |     |

| Process |  |   |   |  |                    |                    |          |                    |   |                     |                     |  |   |                      |  |
|---------|--|---|---|--|--------------------|--------------------|----------|--------------------|---|---------------------|---------------------|--|---|----------------------|--|
| Actor   | $(Pr_1)$   | (Pr <sub>2</sub> )  | (Pr <sub>3</sub> )  | $(Pr_4)$   | (Pr <sub>5</sub> ) | (Pr <sub>6</sub> ) | $(Pr_7)$ | (Pr <sub>8</sub> ) | $(Pr_9)$  | (Pr <sub>10</sub> ) | (Pr <sub>11</sub> ) | $(Pr_{12})$  | (Pr <sub>13</sub> )   | $(\mathbf{Pr}_{14})$ | (Pr <sub>15</sub> )  |
| Arı     | $\begin{array}{c} S_1 = 8 \\ L_1 = 7 \\ A_1 = 8 \\ P_{1,1} = 9 \\ P_{1,2} = 9 \end{array}$ | S <sub>1</sub> =8<br>L <sub>1</sub> =7<br>A <sub>1</sub> =8<br>P <sub>1.1</sub> =9<br>P <sub>1.2</sub> =9 | S <sub>1</sub> =8<br>L <sub>1</sub> =7<br>A <sub>1</sub> =8<br>P <sub>1.1</sub> =9<br>P <sub>1.2</sub> =9 | $\begin{array}{c} S_2 = 7 \\ L_{2,1} = 6 \\ L_{6} = 6 \\ L_{2,2} = 6 \\ A_{2,1} = 7 \\ A_{2,2} = 5 \\ P_2 = 7 \\ S_6 = 9 \\ L_6 = 6 \\ L_{2,1} = 6 \\ L_{2,1} = 6 \\ L_{2,2} = 6 \\ A_{6,1} = 7 \\ A_{6,2} = 5 \\ P_6 = 5 \end{array}$ |                    |                    |          |                    | $S_{6}=9$ $L_{6}=6$ $L_{2.1}=6$ $L_{2.2}=6$ $A_{6.1}=7$ $A_{6.2}=5$ $P_{6}=5$ |                     |                     | $\begin{array}{c} S_{9}{=}7\\ L_{9,1}{=}8\\ L_{9,2}{=}7\\ A_{9}{=}8\\ P_{9}{=}7 \end{array}$ | $\frac{S_{10}{=}8}{L_{10}{=}8}$ $\frac{A_{10}{=}8}{P_{10}{=}8}$ |                      | S <sub>12</sub> =6<br>L <sub>12</sub> =8<br>A <sub>12</sub> =8<br>P <sub>12</sub> =8 |

| Ar <sub>2</sub> | S <sub>1</sub> =8<br>L <sub>1</sub> =7<br>A <sub>1</sub> =8<br>P <sub>1.1</sub> =9<br>P <sub>1.2</sub> =9 | S <sub>1</sub> =8<br>L <sub>1</sub> =7<br>A <sub>1</sub> =8<br>P <sub>1,1</sub> =9<br>P <sub>1,2</sub> =9 | S <sub>1</sub> =8<br>L <sub>1</sub> =7<br>A <sub>1</sub> =8<br>P <sub>1.1</sub> =9<br>P <sub>1.2</sub> =9 | $\begin{array}{c} S_2 = 7 \\ L_{2,1} = 6 \\ L_6 = 6 \\ L_{2,2} = 6 \\ A_{2,1} = 7 \\ A_{2,2} = 5 \\ P_2 = 7 \\ S_6 = 9 \\ L_6 = 6 \\ L_{2,1} = 6 \\ L_{2,2} = 6 \\ A_{6,1} = 7 \\ A_{6,2} = 5 \\ P_6 = 5 \end{array}$ |  |  |  |  | S <sub>6</sub> =9<br>L <sub>6</sub> =6<br>L <sub>2.1</sub> =6<br>L <sub>2.2</sub> =6<br>A <sub>6.1</sub> =7<br>A <sub>6.2</sub> =5<br>P <sub>6</sub> =5 | S <sub>7</sub> =8<br>L <sub>7</sub> =7<br>A <sub>7</sub> =8<br>P <sub>7</sub> =7 | S <sub>8</sub> =6<br>L <sub>8</sub> =7<br>A <sub>8</sub> =7<br>P <sub>8</sub> =6 | $\begin{array}{c} S_{9}{=}7\\ L_{9,1}{=}8\\ L_{9,2}{=}7\\ A_{9}{=}8\\ P_{9}{=}7 \end{array}$ | $\begin{array}{c} S_{10}{=}8\\ L_{10}{=}8\\ A_{10}{=}8\\ P_{10}{=}8\\ \end{array}$ |  | S <sub>12</sub> =6<br>L <sub>12</sub> =8<br>A <sub>12</sub> =8<br>P <sub>12</sub> =8 |
|-----------------|---|---|---|---|--|--|--|--|---|--|--|--|--|--|--|
| Ar <sub>3</sub> | $ \begin{array}{c} S_1 = 8 \\ L_1 = 7 \\ A_1 = 8 \\ P_{1.1} = 9 \\ P_{1.2} = 9 \end{array} $              | $\begin{array}{c} S_1 = 8 \\ L_1 = 7 \\ A_1 = 8 \\ P_{1.1} = 9 \\ P_{1.2} = 9 \end{array}$                | $S_{1}=8 \\ L_{1}=7 \\ A_{1}=8 \\ P_{1.1}=9 \\ P_{1.2}=9$   |   |  |  |  |  |   |  |  |  |  |  |  |
| Ar <sub>4</sub> |   |   |   | $S_{2}=7$ $L_{2,1}=6$ $L_{6}=6$ $L_{2,2}=6$ $A_{2,1}=7$ $A_{2,2}=5$ $P_{2}=7$   |  |  |  |  |   |  |  | $S_9=7$<br>$L_{9.1}=8$<br>$L_{9.2}=7$<br>$A_9=8$<br>$P_9=7$                                  |  |  |  |
| Ar <sub>5</sub> |   |   |   |   | $S_3=6$<br>$L_5=7$<br>$A_3=6$<br>$P_3=7$ | $S_4=5$<br>$L_4=7$<br>$A_2=7$<br>$P_4=8$ | $S_5=7$<br>$L_5=8$<br>$A_5=8$<br>$P_5=7$ | $S_5=7$<br>$L_5=8$<br>$A_5=8$<br>$P_5=7$ |   | $S_7=8$<br>$L_7=7$<br>$A_7=8$<br>$P_7=7$   | $S_8=6$<br>$L_8=7$<br>$A_8=7$<br>$P_8=6$   |  |  | $S_{11}=7$<br>$L_{11}=6$<br>$A_{11}=7$<br>$P_{11}=7$ |  |
| Ar <sub>6</sub> |   |   |   |   |  |  |  |  |   |  |  |  | $S_{10}=8 \\ L_{10}=8 \\ A_{10}=8 \\ P_{10}=8$                                     |  |  |
| Ar <sub>7</sub> |   |   |   |   |  |  |  |  |   |  |  |  | $S_{10}=8$<br>$L_{10}=8$<br>$A_{10}=8$<br>$P_{10}=8$                               |  |  |

# Table 3.Quantified actor-process metrics considering weightages

| Process         |                   |                   |                   |                   |                  |                  |                   |                    |                   |                  |                  |                  |                  |                      |                     |
|-----------------|-------------------|-------------------|-------------------|-------------------|------------------|------------------|-------------------|--------------------|-------------------|------------------|------------------|------------------|------------------|----------------------|---------------------|
| Actor           | $(Pr_1)$          | $(Pr_2)$          | $(Pr_3)$          | $(Pr_4)$          | $(Pr_5)$         | $(Pr_6)$         | $(\mathbf{Pr}_7)$ | (Pr <sub>8</sub> ) | $(Pr_9)$          | $(Pr_{10})$      | $(Pr_{11})$      | $(Pr_{12})$      | $(Pr_{13})$      | $(\mathrm{Pr}_{14})$ | (Pr <sub>15</sub> ) |
| Ar <sub>1</sub> | <mark>41**</mark> | <mark>41**</mark> | <mark>41**</mark> | 76***             | 0                | 0                | 0                 | 0                  | <mark>44**</mark> | 0                | 0                | <mark>37*</mark> | <mark>32*</mark> | 0                    | <mark>30*</mark>    |
| Ar <sub>2</sub> | <mark>41**</mark> | <mark>41**</mark> | <mark>41**</mark> | 76***             | 0                | 0                | 0                 | 0                  | <mark>44**</mark> | <mark>30*</mark> | <mark>26*</mark> | <mark>37*</mark> | <mark>32*</mark> | 0                    | <mark>30*</mark>    |
| Ar <sub>3</sub> | <mark>41**</mark> | <mark>41**</mark> | <mark>41**</mark> | 0                 | 0                | 0                | 0                 | 0                  | 0                 | 0                | 0                | 0                | 0                | 0                    | 0                   |
| Ar <sub>4</sub> | 0                 | 0                 | 0                 | <mark>44**</mark> | 0                | 0                | 0                 | 0                  | 0                 | 0                | 0                | <mark>37</mark>  | 0                | 0                    | 0                   |
| Ar <sub>5</sub> | 0                 | 0                 | 0                 | 0                 | <mark>26*</mark> | <mark>27*</mark> | <mark>30*</mark>  | <mark>30*</mark>   | 0                 | <mark>30*</mark> | <mark>26*</mark> | 0                | 0                | <mark>27</mark> *    | 0                   |
| Ar <sub>6</sub> | 0                 | 0                 | 0                 | 0                 | 0                | 0                | 0                 | 0                  | 0                 | 0                | 0                | 0                | <mark>32*</mark> | 0                    | 0                   |
| Ar <sub>7</sub> | 0                 | 0                 | 0                 | 0                 | 0                | 0                | 0                 | 0                  | 0                 | 0                | 0                | 0                | <mark>32*</mark> | 0                    | 0                   |
| Still           |                   |                   |                   | * Bree            | eze              |                  |                   | ** Wind            |                   |                  | ***              | *** Storm        |                  |                      |                     |

| SAP-LAP Index | <mark>10</mark> | 20 | <mark>30</mark> | <mark>40</mark> | <mark>50</mark> | <mark>60</mark> | <mark>70</mark> | <mark>75</mark> | <mark>80</mark> | <mark>90</mark> | <b>100</b> |
|---------------|-----------------|----|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------|
| of change     |                 |    |                 |                 |                 |                 |                 |                 |                 |                 |            |
| Action        | Neglect         |    | Care            |                 |                 |                 | Cautiou         | S               | I               | Extreme         |            |
| recommended   | _               |    |                 |                 |                 |                 |                 |                 | 0               | Cautious        | 6          |

Figure 3. Regions showing the impacts of change

### New constants in the system of Verhulst equations

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#### ABSTRACT

The given work is the continuation of research results presented by the authors at the international World Congress on Science, Engineering and Technology, July 29-31, 2009, Oslo, Norway (WCSET 2009). Initially authors analyzed the dynamics of two antagonistic populations (two different species of fish: pike and perch) with the help of the system of two recurrent equations on the base of Verhulst-Pearl model. During the research the following areas of change of the parameters, guaranteeing realization of some evolutionary situation, were determined: zones of the steady decisions, zone of bifurcation of occurrence and cycles, zone of chaos and uncertainty. During the continuation of the research authors discovered that the similar phenomenon could be found in the activity of financial markets. In this paper the discovery of the new constants in the system of Verhulst equations is presented.

**Keywords** – bifurcation, chaos, dynamics of populations, fractals.

#### 1. INTRODUCTION

The base discrete model describing limited growth of number of population is the Verhulst model  $x_{n+1} = \alpha x_n (1 - x_n)$ . This model has become the starting point for the whole cycle of works [1,2,3]. Recently [1] the similar phenomena in economy and in financial activity of the markets were analyzed.

Let  $x_n$  be the number of the population of one kind and

 $y_n$  be the number of population of another kind in the year n. Lets now look at the system, containing two iterative equations

$$\begin{cases} y_{n+1} = \alpha x_n (1 - x_n) \\ x_{n+1} = \beta y_{n+1} (1 - y_{n+1}) \end{cases}$$
(1)

The detailed explanation of mathematical calculations for this paper can be found in [9]. In the paper [4] the questions of self-destruction within one population type has been discussed. The authors of this article consider the classical works of S.P. Kuznezov [5, 6] to be the closest to their theme of study. The theoretical bases for the self-destruction phenomenon can be found in the classical works [7, 8]).

#### 2. AREAS OF VARIOUS BEHAVIORS

Our research is significantly facilitated if we note that difference system (1) in its essence is the simple iterative scheme for the roots of the system of the nonlinear equations

$$\begin{cases} y = \alpha x(1-x) \\ x = \beta y(1-y) \end{cases}$$
 (2)

The solution of which has the following form

$$x_{1} = 0, \qquad x_{2} = \frac{2}{3} + \frac{A}{6\beta\alpha} + \frac{2(\alpha - 3)\beta}{3A},$$
$$x_{3} = \frac{2}{3} + \frac{A(-1 + i\sqrt{3})}{12\beta\alpha} - \frac{(\alpha - 3)\beta(1 + i\sqrt{3})}{3A},$$
$$x_{4} = \frac{2}{3} - \frac{A(1 + i\sqrt{3})}{12\beta\alpha} + \frac{(\alpha - 3)\beta(-1 + i\sqrt{3})}{3A},$$

where

$$A = \sqrt[3]{(36\alpha\beta - 8\alpha^2\beta - 108 + 12\sqrt{g})\alpha\beta^2},$$
$$g(\alpha, \beta) = 81 - 54\alpha\beta + 12\alpha\beta^2 - 3\alpha^2\beta^2 + 12\alpha^2\beta \qquad (3)$$



**Fig. 1.** Demonstrates the dynamic regime of system (1): 1area, where both kinds of species degenerate; 2- area, where the number of both species is stabilizing; 3- area with the border  $g(\alpha, \beta) = 0$ , where the cycles  $S=2^1$  occur; 4 - areas of the transfer between the cycle areas and the areas of development of the dynamic chaos.



#### 3. ZONES OF CYCLES AND SPECIAL POINTS OCCURRENCE

Fig. 2. On the left: the map of the dynamic regime of the system (1). On the right : analogues of Julia Fractals on the border of the zones with several cycle numbers:

- 1- area, where both kinds of species degenerate;
- 2- area, where the number of both species is stabilizing;
- 3- area, where the cycles  $S=2^{1}$  occur;
- 4- area, where the cycles  $S=2^2$  and more occur; 5- area, where the cycles  $S=3^1$  and more occur;
- 6 areas of the transfer between the cycle areas and the areas of development of the dynamic chaos.

The border of cyclic zones with the different order (Fig.2. Left) gives us in the cross-section (Fig. 2 Right) well known points of branching of series of cycles, where  $x_{n+1} = a x_n (1 - x_n)$  for

 $n \rightarrow 2n$ : if a = 3, then  $1 \rightarrow 2$ ;  $a = 1 + \sqrt{6}$ , then  $2 \rightarrow 4$ ; a = 3,543, then  $4 \rightarrow 8$ ; a = 3,563, then  $8 \rightarrow 16$ ; a = 3,568, then  $16 \rightarrow 32$ .

A series of cycles  $2^n$  comes to an end at  $a \approx 3,575$ . For the large values *a* the cyclic decisions either are absent, or have very large length.

At  $a=1+\sqrt{8}$  there are two cycles of length 3 steady and unstable. At the further growth  $\alpha$  length of a steady cycle runs consistently:  $3, 6, 12, 24, ..., 3 \times 2^n$ . It is also possible to receive the other values of parameter for occurrence of cycles of other length.

During the study of the system equations (1) the fact of occurrence of essentially new points, new constants was discovered by authors:



Fig. 3. The dashed line designates the greatest possible width of attractors. The most complex phenomenon occurs at such values of parameters  $\alpha$  and  $\beta$ , at which the width of attractors is increasing to the point, where attractors begin to overlap. In this case iterations begin to be overthrown from the area of activity of one attractor into the activity area of another attractor.

Equating  $x_2 = x_3$ , we shall receive the equation of a curve of the beginning of overlapping of attractor. Using symmetry it is possible to accept  $x_3 = 1 - x_1$  and to simplify expression:  $x_2 = 1 - x_1$  or

$$\frac{\alpha\beta^2}{4}\left(1-\frac{\beta}{4}\right)\left[1-\frac{\alpha\beta}{4}\left(1-\frac{\beta}{4}\right)\right] = 1-\frac{\alpha\beta}{4}\left(1-\frac{\alpha}{4}\right)$$

At  $\alpha = \beta$  this expression accepts a kind  $\frac{\alpha^3}{4} \left( 1 - \frac{\alpha}{4} \right) - 1 = 0$ ,

with material meaning of the root

$$\alpha = \frac{2}{3} \left( \sqrt{19 + 3\sqrt{33}} + \frac{4}{\sqrt{19 + 3\sqrt{33}}} + 1 \right), \quad \alpha \approx 3,678.$$

It is an essentially new point, which does not exist in onedimensional case. It is a point of random moving of solutions from one zone into another (Fig.4). Formulas of the borderline (6), (7) look like:  $\alpha\beta(4-\alpha) = 8$ ,  $\alpha\beta(4-\beta) = 8$ . This is the border of the zone 4 solutions. If  $\alpha = \beta$  we have  $\alpha^2(4-\alpha) = 8$  and  $\alpha = \beta = 1 + \sqrt{5}$ . The formula for the borderlines of chaos zone (**Fig.4**), is unknown to authors and at the moment can be only computer approximated.

Consequently, when  $\alpha, \beta \ge 3.678$  an additional way of dynamic chaos formation is appeared. The cause of it is overlapping of the attractors, during which the width of the attractors increases up the point, where a coherent interaction of attractors (overthrown from the *area of activity* of one attractor into the *activity area* of another attractor) can practically have any kind of values (Fig.4).



**Fig.4.** The initial evolution of one cycle proceeds through the conditions:  $0 \rightarrow 1 \rightarrow 2 \rightarrow 3$ , evolution of another cycle proceeds through conditions:  $0' \rightarrow 1' \rightarrow 2' \rightarrow 3'$ . Here the key role is played by the point *A*. It is a point crossing of the diagrams of functions. If the width of the attractor exceeds the excess of the point *o* (or *o'*) above the point *A*, then the iterative cycle  $0 \rightarrow 1 \rightarrow 2 \rightarrow 3$  cannot reach its own attractor (zone of an attraction around the left root), and will move to operative range of a symmetric root.

However, lets note that even in this case there is a possibility to have a coherent interaction of attractors, which results in existence of simple limited cycles  $S = 3^1$  at  $\alpha = \beta = 1 + \sqrt{8}$ , or  $S = 5^1$  at  $\alpha = \beta = 3,7389$ . On the bifurcation diagrams (Fig. 5, 6) such cycles correspond to *Sharkovsky Windows*. Obviously the given configurations also allow their own cascade of bifurcations, which corresponds to the general theory of differentiable mapping.

The results of our computer modeling are shown in a Fig. 5.



**Fig.5.** Evolution of the bifurcation diagram of two-dimensional Verhulst mapping a)  $\alpha, \beta \leq 3.6$ , 6)  $\alpha, \beta \leq 3.9$ . "Fractal cabbage".

The increase of the certain parts of Fig.5. allows to detect the already known phenomena: layered attractors with the fractional Hausdorff dimension, the infinite number of the decreasing in size "windows" of the periodical regimes, forming in cross-sections the iterations of analogues of Sierpinski carpet. Diagonal cross-section at  $\alpha = \beta$ , as it can be seen on the edge of **Fig.5.**, contains the classical diagram of the Feigenbaum fractal (**Fig.6**)



This work is supported by the Grant of Russian Federation RFBR 08-01-00226.

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# Analysis of CR1 repeats in the zebra finch genome

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#### ABSTRACT

Most bird species have smaller genomes and fewer repeats than mammals. Chicken Repeat 1 (CR1) repeat is one of the most abundant families of repeats, ranging from ~133,000 to ~187,000 copies accounting for ~50 to ~80% of the interspersed repeats in the zebra finch and chicken genomes, respectively. CR1 repeats are believed to have arisen from the retrotransposition of a small number of master elements, which gave rise to multiple CR1 subfamilies in the chicken. In this study, we performed a global assessment of the divergence distributions, phylogenies, and consensus sequences of CR1 repeats in the zebra finch genome. We identified and validated 34 CR1 subfamilies and further analyzed the correlation between these subfamilies. We also discovered 4 novel lineage-specific CR1 subfamilies in the zebra finch when compared to the chicken genome. We built various evolutionary trees of these subfamilies and concluded that CR1 repeats may play an important role in reshaping the structure of bird genomes.

Keywords: CR1 repeats, comparative genomics, zebra finch, genome.

#### **1. INTRODUCTION**

The zebra finch (*Taeniopygia guttata*) is a songbird belonging to the large avian order Passeriformes. It is an important model for studying neuroscience, development, and evolution of learned vocalizations and communication. Although overall genome structures are similar in the zebra finch and chicken, they differ in chromosomal rearrangements, lineage-specific gene family expansions and other aspects [1]. In this study, we performed a global analysis of CR1 repeats by comparing the zebra finch and chicken genomes.

Most bird species have smaller genomes and fewer repeats than mammals. The genome size of these birds (~1,200 Mb) is approximately 40% of the size of the human genome. Within the repeatmaskable regions, repetitive elements make up only 9-10%, as compared to the 45% in the human genome [1-3]. As a non-LTR (long terminal repeat) retrotransposon, CR1 is one of the most abundant repeat families, belonging to long interspersed nuclear elements (LINEs). There are over 187,000 copies of CR1 repeats in the chicken genome, accounting for ~74% of its interspersed repeats [2]. On the other hand, there are over 133,000 CR1 repeats in the zebra finch genome, making up 48% of its interspersed repeats. Recent work increasingly recognizes that CR1 elements have a greater impact than expected on the evolution of both the chicken and zebra finch genomes [1,4]. It has been suggested that the relatively small genome size of birds in general may reflect selective pressure to optimize metabolism and to minimize the amount of repetitive DNA [3].

A full-length CR1 is estimated to be ~4.5 kb and contains a (G+C)-rich internal promoter region, followed by two proteincoding sequences [2]. The exact function of ORF-1 is unknown. ORF-2 encodes endonuclease and reverse transcriptase domains and catalyzes the critical step of the retrotransposition process. The high specificity of ORF2 reverse transcriptase activity may explain the lack or lower numbers of other nonautonomous elements, including SINEs and pseudogenes in the chicken or zebra finch genomes, respectively [1,2]. Due to the truncation at their 5' ends, most CR1 fragments are left with a few hundred base pairs at their 3' ends, suggesting the premature termination of reverse transcription [4]. Unlike mammalian L1 elements, CR1 elements do not create target site duplications. Although their 5'-UTR are divergent, CR1's 3' UTR are well conserved, ending with 2-4 copies of 8bp repeat (ATTCTRTG) and lacking a polyadenylic acid (poly A) tail, in all chicken CR1 subfamilies, as well as in the turtle CR1 and the ancient L3 element [2].

CR1 elements are divided into subfamilies based on the extent of sequence diversity. The RECON analysis of the chicken genome generated a total of 22 CR1 subfamilies, including 11 full-length (4.1- 4.8 kb) and 11 additional (3' end 1.0 - 1.1 kb) CR1 subfamilies when only 3' end sequences were considered [2]. The evolutionary ages of chicken CR1 subfamilies have also been determined by a transposon-interruption analysis [4,5]. We carried out a phylogenetic analysis of the ORF2 sequences at a fine scale and identified 57 chicken CR1 subfamilies in the chicken genome [6]. The combined evidence indicated that several remarkably divergent CR1 elements have been existing and active in chickens, whereas in mammals a single lineage of L1 has been dominant [2]. The mixing of turtle and chicken CR1 elements in this ORF2-based phylogenetic tree also suggested that the oldest CR1 elements may predate the reptile-bird speciation [2]. Based on CR1 subfamily sequence diversity, a major burst in CR1 amplification was estimated to occur approximately 45 mya and since then gradually declined [4]. However, it is not clear whether these CR1s are still active in these birds at present.

To date, characterization of CR1 repeats has been mainly focused on the chicken [2]. For other birds, most studies have been based on PCR cross-amplification among diverse bird taxa and, therefore, are potentially biased to either conserved regions or limited to closely related species. Due to their unidirectional mode of evolution, CR1 insertions have been used as largely homoplasy-free character states in cladistic analyses of reptiles and birds like chicken, geese and penguins. CR1 insertion loci have also been used to clarify relationships among rockfowls, crows, and ravens.

Pevzner and colleagues identified more human *Alu* subfamilies at a much finer resolution than previously recognized using a novel

method (Alucode) [7]. We have successfully adapted it to analyze primate Alu repeats [8] and chicken CR1 repeats [6]. This method first splits repeat subfamilies based on "biprofiles", i.e. linkage of pairs of nucleotide values and then used the calibration of mutation rates to split subfamilies containing overrepresented individual mutations. In this study, we applied this method to further characterize the zebra finch CR1 elements and identified 34 CR1 subfamilies of which 22 are novel. In addition, we discovered 4 lineage specific CR1 repeat elements in the zebra finch. Considering the zebra finch diverged from the chicken approximately 100 million years ago (mya), our comparative analysis revealed that the activities of CR1 vary in different bird lineages. The new classification of the zebra finch CR1 repeats will provide insight into their diversity and biology.

#### 2. MATERIALS AND METHODS

CR1 element identification: The zebra finch genome assembly (taeGut1) and repeat annotations were downloaded from the UCSC genome browser (<u>http://genome.ucsc.edu/</u>). To investigate the relationship between CR1 subfamilies, repeats were detected as previously described [6]. Briefly, we utilized 57 chicken [6] and 21 zebra finch consensus sequences of the previously described subfamilies from Repbase (http://www.girinst.org/, version 14.08 and [2]). We detected CR1 repeat elements using the slow search option (-s) of RepeatMasker (version open-3.1.0) [9]. For this study, only the 3' terminal region of ORF-2 was used because most CR1 elements are found as short fragments of the 3' region less than 1,000 bp [2]. The default zebra finch CR1 consensus sequences were trimmed to 465 bp from nucleotide positions 3,944 to 4,408 (accession no. U88211), corresponding to amino acid positions 818 to 972 of the consensus protein for ORF-2 (accession no. AAC60281) [3]. We selected all zebra finch CR1 repeats (6,759) with at least 98% length of the 465 bp consensus segments after excluding those containing ambiguous bases (i.e. Ns). Sequence divergences of CR1 elements from the consensus sequences were computed by RepeatMasker as described before. Divergence levels reported by RepeatMasker were corrected for the CpG content of each repeat by  $D_{CpG}$  =  $D/(1+9F_{CpG})$ , where  $F_{CpG}$  is the frequency of CpG dinucleotides in the consensus, and  $\dot{D}_{CpG}$  is further corrected with the Jukes-Cantor formula for multiple substitutions [4]. We calculated the means and standard deviations of the divergence distributions. We used the mean of 9.0 substitutions/site (%) as the threshold to define "young" or "ancient" subfamilies.

Phylogenetic analyses: For major branches within phylogenetic trees, multiple sequence alignments were performed with ClustalW at default settings. MEGA [10] was used to construct neighbor-joining (NJ) trees using the Kimura 2-parameter model. The minimum spanning trees of zebra finch CR1 subfamilies, i.e. the trees with CR1 subfamilies as nodes that minimize the sum of edge distances, were constructed using the Alucode modified specifically for CR1 (i.e. Length = 465). We tested multiple subfamilies as the consensus sequence including CR1-X1 Pass, J2 Pass and E pass. Under the null hypothesis of uniformity, the P-value for the linkage was calculated using the nonparametric computation as described by Price et al [7]. Since this code can run on a wide range of resolutions, it can split a CR1 population into multiple subfamilies. Based on the size of our data (6,759 zebra finch CR1 elements or 24,198 elements extracted from both zebra finch and chicken genomes), we chose MINCOUNT = 60 or 150, respectively. We used CR1-X1 Pass as the consensus sequence with all other default parameters. Under this setting, MS trees had similar stable topologies and numbers of CR1 subfamilies as the conventional NJ method.

#### 3. RESULTS

**CR1 Repeat Identification and Sequence divergence distribution.** We utilized RepeatMasker to identify CR1 elements on the zebra finch genome assembly. We then extracted all nearly-full-length CR1 elements whose insert length was  $\geq$ 98% of the corresponding consensus sequence length (465 bp). Within the repeatmaskable genomic regions, compared to the chicken genome (119.0 repeats/Mb, 16.7 nearly-full-length repeats/Mb), the zebra finch genome shows a significant lower density of CR1 repeats (70.5 repeats/Mb, 6.0 nearly-full-length repeats/Mb). This is in contrast with the three times of enrichment of retrovirus-derived long terminal repeat (LTR) element copies in the zebra finch as compared to the chicken [1].

We performed a CR1 divergence distribution analysis of the zebra finch genome using the 21 previously known CR1 subfamilies. The divergence levels reported by RepeatMasker were corrected by the CpG content of each repeat and multiple hits. We plotted the divergence (i.e. substitution from consensus) distribution by summing all 21 subfamilies (data not shown). In the stacking plot, two peaks of bursts in CR1 amplification was detected (at 0.10 and 0.17) and estimated to occur approximately 28 and 48 mya assuming a substitution rate of  $3.6 \times 10^{-9}$ substitutions/site/year [4]. Notable differences among the distributions were observed when each CR1 subfamily was considered: 1) L1 Tgu, L2 Tgu, K4 Tgu, K3 Tgu, K1 Tgu, and K2 Tgu subfamilies show a dominant "young" divergence profile with a mode less than 0.09 substitutions/site (Table 1, "Y" type); 2) Other subfamilies show a dominant "ancient" divergence profile with a mode greater than 0.09 substitutions/site (Table 1, "A" type. Within them, X1 Pass, J2 Pass and E pass subfamilies have more than 800 elements).

#### Characterization of zebra finch CR1 repeat elements and their relationships at a fine resolution

We categorized the zebra finch CR1 subfamilies using the custom program modified from Alucode [7]. Based on our analysis of 6,759 CR1 repeats from the zebra finch genome, we identified 34 distinct subfamilies: the subfamily composition

 Table 1. Divergences of 21 previously described CR1

 elements in the zebra finch genome

| Subfamily    | Average    | Standard  | Count | Tuno |
|--------------|------------|-----------|-------|------|
| Subtaininy   | Divergence | Deviation | Count | Type |
| CR1-L1 Tgu   | 4.26       | 3.07      | 63    | Y    |
| CR1-L2_Tgu   | 5.58       | 2.51      | 77    | Y    |
| CR1-K4_Tgu   | 6.63       | 1.91      | 223   | Y    |
| CR1-K3_Tgu   | 7.34       | 3.79      | 74    | Y    |
| CR1-K1_Tgu   | 7.43       | 4.67      | 13    | Y    |
| CR1-K2_Tgu   | 7.66       | 4.82      | 34    | Y    |
| CR1-X1_Pass  | 9.72       | 1.95      | 1044  | А    |
| CR1-YB1_Tgu  | 10.48      | 4.37      | 47    | Α    |
| CR1-YB2_Pass | 11.30      | 2.56      | 445   | Α    |
| CR1-J3_Pass  | 11.37      | 2.17      | 184   | Α    |
| CR1-Y_Pass   | 11.83      | 2.75      | 171   | Α    |
| CR1-X2_Pass  | 12.21      | 2.35      | 63    | Α    |
| CR1-J2_Pass  | 12.29      | 1.64      | 836   | Α    |
| CR1-I_Tgu    | 12.30      | 2.89      | 67    | Α    |
| CR1-J1_Pass  | 12.37      | 1.72      | 582   | Α    |
| CR1-X3_Pass  | 12.46      | 1.62      | 109   | А    |
| CR1-Z1 Pass  | 14.10      | 1.94      | 84    | А    |
| CR1-Z2 Pass  | 14.34      | 1.90      | 38    | А    |
| CR1-Y1 Aves  | 16.94      | 3.19      | 246   | А    |
| CR1-E_Pass   | 17.20      | 2.45      | 2104  | А    |
| CR1-Y2_Aves  | 20.25      | 3.40      | 277   | А    |



**Figure 1. The minimum spanning tree of zebra finch CR1 subfamilies.** This tree is based on an analysis of 6,759 zebra finch CR1 repeats. Previously known CR1 subfamilies are labeled in blue while new putative CR1 subfamilies are labeled in red. Large nodes: Subfamilies with more than 300 elements; medium nodes: 200 to 300 elements; small nodes: less than 200 elements. The subfamily number, name, type, count, P-value and sequence divergence within group are: 1. CR1-J2\_Pass\_2, new, 291, 5e<sup>-131</sup>, 0.26; 2. CR1-X1 Pass\_2, new, 153, 9e<sup>-42</sup>, 0.198; 3. CR1-Y1\_Aves, old, 503, 5e<sup>-131</sup>, 0.362; 4. CR1-K4\_Tgu, old, 122, 5e<sup>-59</sup>, 0.126; 5. CR1-E\_Pass\_3, new, 179, 3e<sup>-66</sup>, 0.258; 6. CR1-YB2\_Pass, old, 233, 1e<sup>-52</sup>, 0.235; 7. CR1-L2\_Tgu, old, 136, 8e<sup>-77</sup>, 0.101; 8. CR1-J2\_Pass\_3, new, 102, 1e<sup>-39</sup>, 0.302; 9. CR1-E\_Pass, old, 136, 6e<sup>-28</sup>, 0.251; 10. CR1-X1\_Pass\_3, new, 246, 7e<sup>-24</sup>, 0.198; 11. CR1-E\_Pass\_4, new, 122, 3e<sup>-35</sup>, 0.304; 12. CR1-E\_Pass\_5, new, 306, 3e<sup>-21</sup>, 0.298; 13. CR1-E\_Pass\_6, new, 131, 4e<sup>-32</sup>, 0.262; 14. CR1-Y\_Pass, old, 115, 6e<sup>-56</sup>, 0.239; 15. CR1-X3\_Pass, old, 111, 5e<sup>-60</sup>, 0.248; 16. CR1-Z1\_Pass, old, 224, 4e<sup>-26</sup>, 0.322; 17. CR1-Y\_Pass\_2, new, 59, 2e<sup>-106</sup>, 0.242; 18. CR1-E\_Pass\_7, new, 245, 4e<sup>-48</sup>, 0.255; 19. CR1-J1\_Pass, old, 518, 2e<sup>-60</sup>, 0.238; 20. CR1-J2\_Pass\_9, old, 375, 5e<sup>-139</sup>, 0.239; 21. CR1-J2\_Pass\_4, new, 236, 1e<sup>-377</sup>, 0.24; 22. CR1-J2\_Pass\_5, new, 155, 3e<sup>-344</sup>, 0.23; 23. CR1-E\_Pass\_8, new, 210, 7e<sup>-40</sup>, 0.283; 24. CR1-K4\_Tgu\_2, new, 140, 1e<sup>-90</sup>, 0.138; 25. CR1-X1\_Pass, old, 229, 8e<sup>-49</sup>, 0.191; 26. CR1-X1\_Pass\_4, new, 202, 2e<sup>-59</sup>, 0.186; 27. CR1-X1\_Pass\_5, new, 191, 1e<sup>-T52</sup>, 0.195; 28. CR1-X1\_Pass\_6, new, 89, 1e<sup>-147</sup>, 0.183; 29. CR1-K3\_Tgu, old, 78, 2e<sup>-199</sup>, 0.135; 30. CR1-YB2\_Pass\_2, new, 174, 7e<sup>-79</sup>, 0.24; 31. CR1-E\_Pass\_9, new, 149, 1e<sup>-63</sup>, 0.241; 32. CR1-E\_Pass\_10, new, 252, 3e<sup>-53</sup>, 0.301; 33. CR1-YB2\_Pass\_3, new, 76, 3e<sup>-51</sup>, 0.228; and 34. CR1-E\_Pass\_2, new, 373, 1e<sup>-50</sup>, 0.302.

ranges from 59 to 518 with most subfamilies containing 200-300 elements (P-values for subfamily partition ranges from 1e<sup>-377</sup> to

3e<sup>-21</sup>, see Price et al. [7] for the P-value definition and calculation). We next constructed a minimum spanning (MS) tree for these 34 CR1 subfamilies to summarize their evolutionary relationship (Figure 1, sequences available upon request from the authors). We identified approximately 22 new subfamilies (Figure 1, red dots) besides most of the previously known CR1 subfamilies (Figure 1, blue dots). Generally, we found a good agreement between the divergence distributions and this MS tree. Subfamily Y2\_Aves is the most ancient one. Subfamilies YB2\_Pass, Y\_Pass, E\_pass, J1\_Pass, J2\_Pass and Z1\_Pass are derived from Y2\_Aves. Subfamilies X1\_Pass and X2\_Pass are derived from J1\_pass. Subfamilies Ls and Ks are the youngest subfamilies and they are directly derived from J1 Pass.

# Characterization of lineage-specific CR1 repeat elements from turkey sequences

We used two distinct approaches to study lineage-specific CR1 subfamilies in the zebra finch-chicken comparison. First, we categorized CR1 subfamilies using the program Alucode [7]. Based on our analysis of 24,198 CR1 elements (6,759 from zebra finch and 17,439 from chicken), we identified 79 distinct subfamilies: the subfamily composition ranges from 102 to 1,065 with most subfamilies containing 500-800 elements (P-value for subfamily partition ranges from 3e<sup>-1068</sup> to 2e<sup>-17</sup>). We next constructed a MS tree for these 79 CR1 subfamilies to summarize their evolutionary relationship (Figure 2). The topology of this tree is similar to the MS tree derived from the zebra finch only (Figure 1). We identified 1) 18 subfamilies shared between chicken and zebra finch ("cz"); 2) 29 subfamilies mainly in the chicken (≥95% by element count, "c"); 3) 10 subfamilies mainly in the zebra finch (≥95% by element count, "z"); 4) 18 subfamilies only in the chicken (labeled as "c\*"); and 5) 4 subfamilies **only** in the zebra finch (labeled as "z\*").

As a second method, we constructed a neighbor-joining (NJ) tree independently for 21 zebra finch CR1 consensus sequences (red symbols), 57 chicken consensus sequences (black symbols) as well as randomly selected 245 zebra finch CR1 repeats (Figure 3). The random samplings of zebra finch CR1 repeats were repeated multiple times and all replicates produced constant results. The zebra finch CR1 lineages include both ancestral and young elements: ancestral ones (Y2 Aves, E Pass, X3 Pass, and etc) may be dead on arrival, while young ones (L1 Tgu, L2 Tgu, and K4 Tgu) may be still active more recently agreeing well with their divergences (Table 1) and MS tree results (Figures 1 and 2). This tree has several major branches: 1) on the left top are zebra finch ancestral subfamilies X1\_Pass, X2\_Pass and X3 Pass, which were old and not supported by bootstrapping. Among them, X1 Pass is interleaved together with chicken Y3, Y4 and Y4 2, which were supported by bootstrapping. 2) On the left bottom are chicken E subfamilies mixed with zebra finch E Pass elements. These E Pass subfamilies might represent degenerated copies of ancestral events. On their right are chicken subfamilies of Ds, Cs and recently derived Bs. 3) On the right bottom is the zebra finch YB2 Pass lineage, which is related to but distinct from chicken subfamilies Gs. Young chickenspecific subfamilies Fs and Y are derived from Gs. Ancient zebra finch Y1 Aves, Y2 Aves, Z1 Pass and Z2 pass are closely related to the chicken Gs. 4) On the right side are the zebra finch subfamilies Js and Is, which have a long branch length (ancient) and do not mix with any chicken consensus sequences. 5) On the right top are the most recent lineage-specific subfamilies: such as L1 Tgu, L2 Tgu and K4 Tgu elements in zebra finch and recent chicken-specific subfamilies X1s, X2s and Hs. Subfamilies K4 Tgu, and K4 Tgu 2 only contain zebra finch



Figure 2. The minimum spanning tree of zebra finch and chicken CR1 subfamilies. This tree is based on an analysis of 6,759 zebra finch and 17,439 chicken CR1 repeats. Lineagespecific subfamilies are labeled red (zebra finch only) or blue (chicken only). Subfamilies with more than 95% elements coming from either bird are labeled pink (zebra finch) or cyan (chicken). Shared subfamilies between 2 bird species are labeled in purple. Large nodes: Subfamilies with more than 500 elements; medium nodes: 300 to 500 elements; small nodes: less than 300 elements. The subfamily number, name, type, count, P-value and sequence divergence within group, chicken element% and zebra finch element% are: 1. G 2, cz, 331, 1e<sup>-156</sup>, 0.233, 77.0%, 23.0%; 2. X1 Pass 2, cz, 400, 2e<sup>-208</sup>, 0.288, 37.5%, 62.5%; 3. C, c, 1065, 2e<sup>-216</sup>, 0.087, 99.6%, 0.4%; 4. X 2, c, 313, 4e<sup>-174</sup>, 0.162, 99.7%, 0.3%; 5. H 2, c\*, 295, 7e<sup>-324</sup>, 0.038, 100.0%, 0.0%; 6. X2\_2, c, 227, 1e<sup>-238</sup>, 0.091, 99.1%, 0.9%; 7. C4\_2, c, 366, 8e<sup>-211</sup>, 0.249, 97.8%, 2.2%; 8. D2\_2, c, 296, 2e<sup>-192</sup>, 0.207, 96.6%, 3.4%; 9. B2, c, 290, 2e<sup>-92</sup>, 0.098, 99.3%, 0.7%; 10. K4 Tgu 2, z\*, 272, 9e<sup>-73</sup>,  $0.13, 0.0\%, 100.0\%; 11. F2_{2}, c, 320, 9e^{-200}, 0.176, 99.7\%, 0.3\%;$ 12. J2 Pass 2, cz, 239, 2e<sup>-17</sup>, 0.278, 63.2%, 36.8%; 13. E 3, cz, 282, 3e<sup>-301</sup>, 0.187, 83.7%, 16.3%; 14. X1, c, 276, 3e<sup>-197</sup>, 0.094, 97.8%, 2.2%; 15. B, c, 204, 3e<sup>-93</sup>, 0.049, 98.5%, 1.5%; 16. Y, c, 277,  $8e^{-201}$ , 0.055, 99.6%, 0.4%; 17. Y4, c\*, 219,  $6e^{-99}$ , 0.26, 100.0%, 0.0%; 18. E\_4, z, 431,  $1e^{-126}$ , 0.276, 0.2%, 99.8%; 19. C4\_3, c, 304,  $7e^{-70}$ , 0.256, 98.0%, 2.0%; 20. F, c, 258,  $3e^{-130}$ , 0.149, 98.4%, 1.6%; 21. D\_2, c, 254,  $2e^{-135}$ , 0.161, 99.2%, 0.8%; 22. C3 2, cz, 195, 6e<sup>-68</sup>, 0.171, 92.3%, 7.7%; 23. Y2 Aves, cz, 380, 2e<sup>-192</sup>, 0.379, 38.2%, 61.8%; 24. C3\_3, c\*, 286, 2e<sup>-30</sup>, 0.168, 100.0%, 0.0%; 25. YB2\_Pass, z, 397, 7e<sup>-T10</sup>, 0.249, 3.8%, 96.2%; 26. J3 Pass, z, 327, 1e<sup>-179</sup>, 0.241, 2.1%, 97.9%; 27. J2 Pass 3,

z\*, 399, 1e<sup>-29</sup>, 0.249, 0.0%, 100.0%; 28. J2 Pass 4, c\*, 343, 1e<sup>-29</sup>  $0.203, 100.0\%, 0.0\%; 29. Y1 Aves, cz, 448, 2e^{-172}, 0.312, 53.8\%,$ 46.2%; 30. Y1 Aves 2, cz, 257,  $2e^{-670}$ , 0.328, 70.0%, 30.0%; 31. G\_3, cz, 508,  $4e^{-106}$ , 0.235, 94.3%, 5.7%; 32. G, cz, 252,  $5e^{-267}$ ,  $\begin{array}{c} \text{C} = 22, \ 223, \ 333\%, \ 6.7\%, \ 33. \ \text{F2} = 2, \ c^*, \ 272, \ 2e^{-309}, \ 0.168, \ 100.0\%, \\ 0.0\%, \ 34. \ \text{J1} = \text{Pass}, \ z, \ 251, \ 5e^{-63}, \ 0.26, \ 2.8\%, \ 97.2\%, \ 35. \ \text{J2} = \text{Pass}, \\ \text{z}, \ 226, \ 2e^{-125}, \ 0.23, \ 4.4\%, \ 95.6\%, \ 36. \ \text{J2} = \text{Pass}, \ z, \ 279, \ 4e^{-240}, \\ 0.248, \ 2.9\%, \ 97.1\%, \ 37. \ \text{J2} = \text{Pass}, \ 6, \ z, \ 165, \ 2e^{-722}, \ 0.258, \ 9.7\%, \\ 0.248, \ 2.9\%, \ 97.1\%, \ 37. \ \text{J2} = \text{Pass}, \ 6, \ z, \ 165, \ 2e^{-722}, \ 0.258, \ 9.7\%, \\ 0.248, \ 2.9\%, \ 97.1\%, \ 37. \ \text{J2} = \text{Pass}, \ 6, \ z, \ 165, \ 2e^{-722}, \ 0.258, \ 9.7\%, \\ 0.248, \ 2.9\%, \ 9.7\%, \ 126, \ 2e^{-722}, \ 0.258, \ 9.7\%, \\ 0.248, \ 2.9\%, \ 9.7\%, \ 126, \ 2e^{-722}, \ 0.258, \ 9.7\%, \\ 0.248, \ 2.9\%, \ 2.9\%, \ 4.7\%, \ 2.7\%, \ 4.5\%, \ 166, \ 2.5\%, \ 166, \ 2.5\%, \ 166, \ 2.5\%, \ 166, \ 126, \ 166, \ 126, \ 166, \ 126, \ 166, \ 126, \ 166, \ 126, \ 166, \ 166, \ 126, \ 166, \ 126, \ 166, \ 126, \ 166, \ 126, \ 166, \ 126,$ 90.3%; 38. X 3, c, 477, 3e<sup>-78</sup>, 0.186, 99.4%, 0.6%; 39. X 4, c\*, 218, 1e<sup>-47</sup>, 0.172, 100.0%, 0.0%; 40. X\_5, c, 243, 5e<sup>-72</sup>, 0.18, 96.7%, 3.3%; 41. X, c, 354, 2e<sup>-1063</sup>, 0.071, 99.4%, 0.6%; 42. H 3, c\*, 493, 9e<sup>-820</sup>, 0.045, 100.0%, 0.0%; 43. H, c\*, 256, 4e<sup>-196</sup>, 0.046, 100.0%, 0.0%; 44. X2 3, c\*, 477,  $3e^{-1068}$ , 0.097, 100.0%, 0.0%; 45. X2\_4, c\*, 264,  $6e^{-545}$ , 0.083, 100.0%, 0.0%; 46. X2, c\*, 102, 1e<sup>-576</sup>, 0.084, 100.0%, 0.0%; 47. X1\_Pass\_3, z, 508, 8e<sup>-136</sup>, 0.193, 3.3%, 96.7%; 48. E 5, cz, 367, 3e<sup>-69</sup>, 0.185, 89.6%, 10.4%; 49. E 6, z, 325, 5e<sup>-69</sup>, 0.252, 0.3%, 99.7%; 50. E, cz, 360, 6e<sup>-71</sup> 0.171, 91.9%, 8.1%; 51. D2, c, 550, 2e<sup>-125</sup>, 0.194, 97.6%, 2.4%; 52. E 7, c, 153, 2e<sup>-68</sup>, 0.155, 96.7%, 3.3%; 53. D2 3, c, 244, 1e<sup>-</sup> <sup>64</sup>, 0.21, 96.3%, 3.7%; 54. D2\_4, c, 236, 2e<sup>-218</sup>, 0.205, 98.3%, 1.7%; 55. D, c\*, 336, 5e<sup>-112</sup>, 0.164, 100.0%, 0.0%; 56. D\_3, c\*, 164,  $2e^{-407}$ , 0.165, 100.0%, 0.0%; 57. C4 4, c, 566,  $2e^{-115}$ , 0.218, 99.5%, 0.5%; 58. C4, c, 336,  $8e^{-88}$ , 0.228, 99.1%, 0.9%; 59. C4 5, c, 194, 1e<sup>-177</sup>, 0.242, 95.9%, 4.1%; 60. C3\_4, c\*, 161, 4e<sup>-151</sup> 0.204, 100.0%, 0.0%; 61. C3, cz, 156, 2e<sup>-91</sup>, 0.208, 94.9%, 5.1%; 62. B2 2, c, 248, 4e<sup>-244</sup>, 0.111, 99.2%, 0.8%; 63. C2, c\*, 445, 1e  $^{366}$ , 0.108, 100.0%, 0.0%; 64. C\_2, c\*, 248, 1e<sup>-70</sup>, 0.098, 100.0%, 0.0%; 65. X1\_Pass, z, 301, 3e<sup>-1041</sup>, 0.196, 1.3%, 98.7%; 66. X1\_Pass, 4, cz, 224, 1e<sup>-290</sup>, 0.247, 17.4%, 82.6%; 67. B\_2, c\*, 3B\_2, 150,  $7e^{-313}$ , 0.052, 100.0%, 0.0%; 68. X 6, c, 237,  $3e^{-226}$ , 0.223, 99.2%, 0.8%; 69. J2 Pass 7, c, 337,  $1e^{-152}$ , 0.199, 99.4%, 0.6%; 70. E 8, z, 370,  $5e^{-149}$ , 0.296, 2.4%, 97.6%; 71. C4 6, c, 216,  $5e^{-149}$ <sup>69</sup>, 0.243, 99.1%, 0.9%; 72. E\_9, cz, 396, 1e<sup>-117</sup>, 0.305, 5.3%, 94.7%; 73. E\_10, cz, 219, 9e<sup>-49</sup>, 0.308, 14.2%, 85.8%; 74. K4 Tgu, z\*, 193, 5e<sup>-115</sup>, 0.148, 0.0%, 100.0%; 75. X1\_2, c, 190,  $1e^{-345}$  $1e^{-345}$ , 0.088, 99.5%, 0.5%; 76. YB2 Pass 2, z\*, 161, 2 $e^{-135}$ , 0.232, 0.0%, 100.0%; 77. Y3, c\*, 186,  $6e^{-T24}$ , 0.224, 100.0%, 0.0%; 78. G 4, c, 151, 5e<sup>-44</sup>, 0.223, 98.0%, 2.0%; 79. E 2, cz, 482, 3e<sup>-72</sup>, 0.307, 44.8%, 55.2%.

elements and do not mix with any chicken subfamilies. They have short length (young), multiple branches (active), suggesting these younger lineage-specific CR1 elements may still be active in the zebra finch.

#### Subfamily consensus sequences and phylogeny

We also performed a phylogenetic analysis (NJ tree) on 34 zebra finch (with postfix of "ms") identified by the current study and 21 previously known zebra finch CR1 consensus sequences. In the NJ tree shown in Figure 4, the relationship among known and new CR1 consensus sequences was recovered as expected. Out of 21 known subfamilies, 12 were confirmed and covered by new consensus sequences (labeled as black brackets). The sequence distances between known consensus sequences and their closest neighbors range from 0.011 to 0.052, with an average of 0.028 and standard deviation of 0.014. The few discrepancies between our consensus sequences and the consensus sequences reported in Repbase occur mostly at CpG dinucleotide positions, which are ill-determined because of frequent mutation. In spite of the above-mentioned ancestry sharing, 22 new consensus sequences were discovered (Figure 4, labeled by red brackets). The new subfamilies include CR1-J2 Pass (4), CR1-X1 Pass (5), CR1-E Pass (9), CR1-YB2 Pass (2), CR1-Y Pass (1), and CR1-K4 Tgu (1). Overwhelming majority of newly discovered



**Figure 3.** The neighbor-joining tree of zebra finch-chicken CR1 comparison. This neighbor-joining tree includes 21 previously known zebra finch CR1 consensus sequences (red symbols), 57 chicken consensus sequences (black symbols) as well as randomly selected 245 zebra finch CR1 repeats (lineages without dots). The major branches are labeled with subfamily names. See main texts for details.

consensus sequences come from those subfamilies with many elements, including subfamilies X1\_Pass, J2\_Pass and E\_Pass. Those missed subfamilies (not bracketed) are likely due to the high threshold (MINCOUNT=60) of Alucode.

#### 4. DISCUSSION

In this project, we performed a global characterization of CR1 elements in the zebra finch genome using an integrated approach combining two distinct phylogenetic methods: NJ and MS trees. We identified 34 zebra finch CR1 consensus sequences. Our analysis supports a model in which a burst of CR1 activities occurred between 28-48 mya, with multiple master CR1 genes involved in the zebra finch lineages. These observations generally support that CR1 subfamilies originated through the serial fixation of multiple master CR1 elements. We further identified 4 zebra finch specific CR1 subfamilies.

Our results have confirmed previous analysis [4] as well as provided new insights with respect to evolutionary relationships of the zebra finch CR1 subfamilies. The earlier results based on insertion order/rank analysis in chickens suggested that 1) X, X1, Y4, and C4 are the most ancient CR1 subfamilies, with C4 being the most common; 2) C, C3, D, D2, E, G, H, X2, Y and Y3 represent the major burst of CR1 elements and 3) B, B2, C, C2, F, F0, F2, H2 and Y2 are among the youngest subfamilies. On the other hand, our earlier data indicated that a subset of CR1-G belongs to the most ancient group and parts of CR1-H, X, X1, and X2 belong to the youngest group [6]. The current study further confirmed our earlier data: CR1\_Y2\_Aves are the most ancient repeats shared by the zebra finch and chicken. Chicken CR1-Gs derived from Y2\_Aves via YB2\_Pass. Younger lineagespecific CR1 elements like K4\_Tgu may still be active in zebra finch.

As discussed before [6], one source of these discrepancies may be that we limited our analyses to the 465 bp of the 3' terminus (155 amino acids) of ORF2. Other studies are based on longer 3' terminus (~1,000 bp) of or full length ORF2 [4]. Since the vast majority of CR1s are fragments shorter than 1,000 bp, filtering of RepeatMasker output with a shorter length requirement will preserve more CR1 copies, thus making our samples more representative. Another difference is that two



0.05

Figure 4. The neighbor-joining tree of previously known and newly discovered zebra finch CR1 consensus sequences. This neighbor-joining tree includes 34 zebra finch (with postfix of "ms") identified by the current study and 21 previously known zebra finch CR1 consensus sequences. The confirmations of previously known consensus sequences by the new zebra finch CR1 subfamilies are labeled by black brackets. The newly derived subfamilies are labeled by red brackets. All branches are labeled with the bootstrap values (>50%) with n=1,000 replicates.

distinct methods were used. The insertion order/rank method does not directly depend on sequence divergences but instead depends on the RepeatMasker program to properly assign repeat subfamily [5]. The accuracy of that method also depends on the repeat length and their connectedness with other repeats. The proper subfamily assignment of repeats by RepeatMasker depends on the fact that the consensus sequences are properly constructed and thoroughly verified. Therefore, our results of 34 zebra finch CR1 subfamilies offer a new refined prospective for CR1 classification and evolution.

In summary, our analysis has provided an evolutionary framework for further classification and refinement of the CR1 repeat phylogeny. These new CR1 subfamilies expand our understanding of CR1 evolution and their impacts on bird genome architecture. The differences in the distribution and rates of CR1 activity may play an important role in subtly reshaping the structure of the zebra finch genome. The structural and functional consequences of these changes among the bird genomes are an important area for future investigation.

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# Service-Oriented Architecture for Prevention of Nosocomial Infections

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#### ABSTRACT

Information technologies have proliferated in different sectors of society, allowing development of applications that have managed to facilitate their activities. Health is a sector that has incorporated the information technologies and has managed to automate processes. This work presents the implementation of the monitoring of hand washing and analysis of patients in a hospital neonatology area. This is done through use of sensors, cameras and devices that provide input data. Its development is based on services-oriented architecture and its implementation has the objective of preventing nosocomial infections in hospitals.

*Key Words: Service-Oriented Architecture, Web Service WSDL architecture.* 

#### **1. INTRODUCTION**

The need of our time in the health area requires that their processes contribute to take better control of the medical procedures and facilitate their performance. The area of health, which has a variety of specialties, has had a major technological breakthrough. One of the most important areas of health, is the hygiene to prevent infection, since this leads to improve or worsen the health of the patient. This is according to studies around the world [1]. In spite of the efforts made in the world to eradicate infectious diseases, they remain one of the main causes of morbidity and mortality. Infection in epidemiological terms means penetration, multiplication, and invasion of an infectious agent in the body of man or animal [3]. Nosocomial term comes from the Greek Nosokomeain, "Hospital", which in turn is derived from the Greek word Nosos "several diseases" [4]. And here that the apparent infection with hospitalization is enough for the diagnosis of nosocomial infection. Nosocomial infection is the infection acquired

during hospitalization and that was not present or incubating at the time of the entry of the patient [2].

To make an infection happen requires several factors: A sufficient number of pathogenic micro-organisms, a susceptible host and an environment to come into contact with the guest. This group of infections is the result of the same care and they are favored by their own conditions of the host that are altered as malnutrition, birth defects, premature birth or immunosuppression status [2].

Nosocomial infections are a problem in public or private hospitals. This problem involves a greater cost to the institutions, patients and their families, increases hospital stay and increased morbidity and mortality of more vulnerable individuals. The sicker is the patient; greater is the risk of collapse any such infection and die because of it. However, in most of the hospitals, there are no programs to determine the magnitude of the problem causing the establishment of policies and corrective measures to resolve. This situation accentuates most in the developing countries. In these, there is a rate of lethality of 12% to 52% in neonatal cases which is twelve times higher than in developed countries [1].

The specific cases of nosocomial infections contracted during the neonatal care are among the main causes of serious illness and death. Most deaths and suffering caused by infections related to health care can be avoided. There are simple, cost-effective practices to prevent them. A simple action: Hands hygiene remains the primary measure to reduce the incidence and spread of antimicrobial-resistant microorganisms which improves the safety of the patient in all areas [1] [2]. However, hand hygiene compliance is very low worldwide. This article presents an architecture hardware and software that enables the monitoring of the washing of hands in the neonatal hospital space area.

Our goal is to provide a solution to dramatically reduce the spread of these infections through the monitoring of cleanup in the washing of hands and consequent decisionmaking for the improvement.

This work describes the hand-washing monitoring for preventing nosocomial infections in infants, to carry this out, monitoring has strategically distributed in a neonatal care area (NCA), which capture the images and videos, to later make the digitalization of these images. And make use of this information in the Medical Center.

This article is organized as follows. Section 2 describes the approach to conduct the investigation. Section 3 shows the process and methodology to solve the problem. Section 4 describes Service-oriented architecture. Section 5 shows the implementation of the proposed prototype. Section 5 presents the results, and finally, sections 6 and 7 show conclusions and future work.

#### 2. APPROACH TO THE PROBLEM

In order to understand and analyze how produced nosocomial infections in the area of a hospital, research was carried out in a public hospital, we conducted interviews with nurses and medical pediatricians, conducted context studies and follow-up, and identified the area where the problem was critical studies.

We began to analyze the hospital areas that had a high percentage of infections and more risk and identified the scope of the problem. The causes that gave nosocomial infections, as well as how they spread were investigated. According to these results, we identify the components of the problem.

In the medical personnel review process, they presented a very accurate solution, the hand hygiene, which is regarded as the most important measure of prevention and care-related infections control health.

We defined a methodology and regulation to perform this procedure from the washing of hands, defining objectives and alternatives for managing information and how to control the roles that makes each participant. The following section defines the process that followed and methodology

#### **3. PROCESS AND METHODOLOGY**

To obtain the necessary data we conducted interviews in the Hospital, the doctor responsible for the area of Neonatology, which described us in detail the procedure followed in the NCA, the role of each staff member, the review of babies infants, as well as hand-washing hygiene.

We took 48 hours videos to monitor normal activity within NCA in 3 different shifts, in order to observe and later set to implement washing of hands, control as well as a source of information to help determine if the wrong hand washing, causes complications in the newborn health.



Figure 1. Neonatal Care Area (NCA)

The NCA where made preliminary testing consists of 7 cots where the babies are placed to be observed, also has a sink and a soap dispenser liquid, where medical staff performs the hygiene of their hands. This area working three shifts a day, so there is a role of personnel for each turn. In each shift work 7 people between medical pediatricians, nurses, nutritionists, psychologists, among others. Having tracked activities, we performed the physical structure of the prototype, where we determined the location of sensors and cameras.

The electronic element used for detection of bodies with infrared sensors, also to make the recordings made with webcam to the gathering of information. Sensors were placed in each cradle to detect when the doctor begins to listen to the patient, are also placed the cameras in each one of the cradles for recording, for staff identify and obtain more accurate data on the activities carried out in that area.

Proximity sensors were installed in the toilet, to register the fall of the water, and get the number of times that hand-washing is performed. Similarly Web Cam is placed on the wall where hand-washing is located.

Already-processed information is sent to the hospital data base, where later the information can be consulted by means of a piece of software called data server called SIEM (comprehensive system of medical specialties). This system was developed under a Visual Basic 2008, .NET platform. SIEM was adapted to provide information over desktop computing teams as well as mobile computers. It can generally be used by internal staff of the hospital, but due to the Service oriented architecture in which this system was implemented, there

is a possibility of any medical center services can query results on the Internet.



Figure 2. Basic Architecture

# 4. SERVICE-ORIENTED ARCHITECTURE TO PREVENT NOSOCOMIAL INFECTIONS

We designed a basic architecture for the hand washing monitoring in the Centre of health data management. Their main components are made up by drives for data, video, and image processing. Data storage and capture/query data units.

Figure 2 shows the used architecture, it is a client-server 2 layers architecture, since applications will be processed in a terminal, and via internet.

Images and videos are captured by the cameras and sensors and are stored in a dedicated server of images and video. The information gained from process images, and video; data on patients and medical staff are kept in a database server. Web services are located on another server.

The application is processed from a server that can be used by a thin client, but also from different workstations. All servers are part of the hospital intranet and access can be done directly by local users on the LAN or by means remote access. They can transmit information from the server wired or wireless. Service oriented technology allows information to be selected and required from other hospitals.

#### 4.1 Service oriented Architecture (SOA)

SOA is a style of software architecture based on the definition of reusable services with well-defined public interfaces, where the suppliers and consumers of services interact in decoupled form to perform business [4]. This architecture is based on four basic abstractions:

**Operation:** Is the unit of work or processing in SOA architecture.

**Service:** Logical entity that is a container of logic and is composed of a set of operations, which offer to their users.

**Message:** To run a particular operation, need a set of input data that after performing the operation, it returns a result. Messages are responsible for encapsulating that data input and output.

**Business Process:** They are a set of transactions executed in a particular sequence (exchanging messages between them) in order to perform a particular task. As shown in Figure 3.



#### Figure 3. SOA components

#### 4.2 Web services

SOA makes use of Web services, these services are built on protocols and languages such as HTTP, XML, UDDI and WSDL, which involved in the dynamic discovery of services. Interfaces are described in XML and communication messages are done over HTTP.

Enterprise Service Bus (ESB) is the middleware we used to the integration of distributed systems, management of the components and integrate access to repositories on multiple platforms and repositories of information. Our design components consist of several processes which define the services that are part of these models.

The Image processing is responsible for scanning the videos and images pulled from recording and sensing, from here the identification of medical personnel, the patient, the activity that performs data is extracted (washing of hands, patient analysis), the time it takes to complete each activity and the count of times performing each activity.

The procedures performed are as follows: The process of registry data, during which stores information processing images as data coming from other processes. The rules for laundering is the process where qualifies if handwashing is correct. The people checking, classifies person types, this is where each person type data are recorded. Statistics process, produce the statistics and results from all procedures.

#### **5. RESULTS**

To undertake the study in the hospital on problems of nosocomial infections and how to prevent them, neonatology area is where most need to control these infections found since the newborns are more susceptible to this type of infection. So the hand-washing monitoring proposal is implemented. It presented difficulties for the location of items to perform monitoring, the beds could be moved, so the location of sensors was changed several times, and keep the concept of ubiquitous computing was complicated.

The use of the service oriented architecture has benefits such as the reuse of code, interoperability, flexibility and profitability. This architecture makes it easy to support from developers which will be responsible for control of the information of the hospital this due to the use of Web services and the ability to consume these services both the hospital and external users. Our research and implementation is a contribution to health administration, in which we are integrating information technology as architecture that aid in the management of data, using the Internet.

#### 6. CONCLUSIONS AND FUTURE WORK

Our project is still in development. Thought that you making use of the best elements of technology to improve the identification of staff is monitoring and provides the input data that are necessary to maintain a qualified information. We plan to extend the prototype of handwashing monitoring in all areas of the hospital to the spread of nosocomial infections. It should be necessary therefore consider the location of sensors and cameras. With the purpose of feeding information that helps the patient's clinical history and get statistical data at the hospital and to external users

#### 7. ACKNOWLEDGMENTS

This work has been supported by grant: PROMEP-CAs-RED-RIGSTI-2009-2010, and partially supported by grants C09-FAI-03-35.35 and PROMEP/103.5/09/4280.

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#### Knowledge Transfer in Collaborative Knowledge Management: A Semiotic View

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#### Abstract

Codification and transfer of knowledge is essential in the practice of knowledge management. Theoretical knowledge, like scientific theories and models, by nature comes in coded representation for the explicit purpose of transfer. Practical knowledge, as involved frequently in engineering or business operations, however, is a priori uncoded, making transfer for further use or the generation of new knowledge difficult. A great deal of systems engineering effort in recent years has been focused on issues related to this sort of knowledge resolving transfer. Semantic technologies play a major role in here, along with the development of ontologies. This paper presents a semiotic perspective on transfer of knowledge within collaborations.

**Keywords:** Knowledge management, collaboration, knowledge transfer, semiotics, semantic technologies, ontologies

#### 1 Introduction

Current semantic technology engineering builds upon the use of ontologies for the description of factual, conceptual or procedural entities. The goal is to make information machine-readable and -interpretable so that the meaning of given data can be grasped for further use, in particular for further processing in electronic systems and applications. In business practice, the information needed to run operations or manage transactions is always related to a specific business context. Information gets its meaning in that context, and usually triggers a decision, an action or activity in it. The flow of meaningful information, we say the transfer of knowledge, guides the operations of an organization. Clarity and unambiguity of knowledge transferred thus become essential requirements to ensure an operation will function well, or a transaction will lead to the desired result. This applies in the case of single organizations, but even more to collaboration across several different organizations. Process, data and

application integration across organizational boundaries require as a precondition well defined and implemented routines for knowledge transfer; and the knowledge exchanged must be interpreted correctly to entail the appropriate action. This raises the question of equal understanding of knowledge objects by all actors involved in a collaborative activity, each one having their own contextual sphere of interpreting a unit or set of information.

The predominant approaches for handling this question using information technology are subsumed into the term semantic technologies. In general they build upon i.e., referencing schemes ontologies. comprising vocabulary and syntax to describe a certain knowledge domain. The aim is to construct comprehensive languages that can be used for electronic documentation and communication of information, in particular in machinereadable form. In recent years, a number of standards and tools for the construction of ontologies have been developed, and various examples of domain specific ontologies have been suggested. The general concept is that all communication systems work on the basis of underlying codes (Eco, [3]). While this does not necessarily mean that all signs used with a code are verbal, or can at least be attributed to the rules of language (Saussure, [4]), semantic technologies at present are very much focused on verbal codes. However, the issue of semantic variety [12] requests, in particular in the case of automated machine-based communication, to take into view the unambiguous understandability of every message transferred. A sign - and consequently a term is something that stands for some other thing, in a certain respect or based upon a certain capacity of someone (Peirce, [11]). Any coded information then gets its meaning not independent from connotation, but within an actual context ideally providing that connotation. These considerations suggest taking a view of knowledge transfer and semantic technologies facilitating it from the perspective of semiotics.

The focus on machine-readable information is not however exclusive. Some of these same issues will arise in requirements analysis and design of collaborative information- and knowledge-intensive systems, including but not limited to software development. In fact, since there is more awareness and more study of the former, we will consider both issues in the balance of this paper.

The paper is structured as follows. At first, the field of semiotics is characterized as described by Eco, Saussure, and Peirce: every communication is based on codes consisting of systems of symbols/signs established by cultural convention. This has numerous implications for the sourcing, sharing and use of knowledge. Such implications of semiotics for knowledge management are discussed in the second section, in particular for the externalization, internalization and transfer of knowledge in collaborative settings. In section 3, recent advancements in the area of semantic technologies, as provided for example by the Object Management Group with their Semantics for Business Vocabulary and Business Rules [9], are investigated as to their supporting function for the engineering of knowledge transfer systems. Basic issues still remaining unsolved are identified, such as the management of non-verbally represented knowledge in collaborative activities, the question of semantic synchronization when ontologies are being used for formal representation of knowledge [12], and collaborative knowledge capture [5]. Finally, we draw conclusions in particular for the facilitation of knowledge transfer within collaborations and further work relating to that.

# 2 Semiotics: the theory of signs and the relation between code and message

Semiotics is the theory of signs (or symbols). Its objective is to investigate the conditions that make messages mediated by signs understandable. According to Eco [3], signs represent 'something' and are always related to codes. Subject to investigation therefore is the general relation between code and message.

Signs are not necessarily verbal, but can also for example be visual, like pictures. There are basic signs (e.g. elementary predicates) and composed signs (e.g. sentences). Both Eco [3] and Peirce [11] point out that signs do not represent 'something' in its totality, but specific aspects according to a certain perspective or practical interest. Such aspects can also be functional, as is the case when pictogrammes (for instance showing an escalator) are used to point to the function (get to the upper floor). However, following Saussure [4], semiotics has been focusing on the investigation of verbal signs, taking into view syntax, semantics and pragmatics; other signs are predominantly being considered only within this horizon. It should be noted that Scholz [13] points out the particular nature of pictures (as signs) being that these, different to verbal signs or mathematical and design notations, cannot be decomposed into an alphabet or vocabulary of distinct syntactical entities.

The basic concept of semiotics involves the semiotic process: something is being signified by a sign -(denotation); this sign is perceived, connotative aspects are - mentally - added, resulting in a cognitive signification (connotation); this signification refers to an instantiation of the something (reference). Obviously this concept requires cognitive capacity with the perceiving subject. The semiotic process is characterized by the fact that there is no direct, immediate influence of a something on the recipient. The relation between something and recipient is mediated by a representational object. This object, the sign, may be a written text, verbal expression or even a picture, which, in the case of an intended communication, bears some meaning to be communicated.

Denotation, connotation and reference are the procedural elements of the semiotic process; the sign/symbol is the mediating object which bears the meaning. When signs are used to communicate information – or transfer knowledge – it appears immediately that the (intended) communication will be successful only if each of the subjects communicating makes an equivalent (or at least compatible) reference to the something in general and in a specific instantiation. Hence the necessary condition for signs to be understandable.

A prerequisite for a sign to be understood by a recipient is correct decoding. In order to be able to decode, a code must be available. The underlying hypothesis of semiotics is that any communication system works on the basis of codes. Codes are systems of symbols which are determined by cultural convention for the purpose of representing information and transferring it from a point of origination to a destination. They must be shared so that decoding becomes possible. According to Eco [3], a code can be vague or weak (change quickly), incomplete, temporarily provisional, or inconsistent. Every communication, however, happens to refer implicitly or explicitly to a code that must be available for each communicating party. So does the exchange of information, and the transfer of knowledge:

(1) In the most simple case of a *signal processing* machine, a code is used to identify certain conditions occurring in a real process (that are relevant to be communicated), and transfer this information to a recipient which, referring to the same code, reconstitutes the message.

(2) The more complicated case is when two or more systems using their specific codes each (for example, components in a supply chain using their individual product numbering schemes) exchange information which originates from processing within one code scheme and generates processing in the other code scheme. Interoperability then can be achieved if and only if there is a bijective relation between the code schemes involved, i.e., when semantic variety or ambiguity is reduced to zero. (This can be relaxed if some codes are allowed to correspond, perhaps non-bijectively, to exceptions or error conditions.) However, remaining issues here on the organizational as well as the IT systems side are openness, flexibility with regard to modification and adaptation, and configurability [7]. Similar concerns apply to the use of different processes, vocabularies or design notations, even when used by a single development team.

(3) The complex case is that of *collaboration*, i.e., when information resulting from an action or activity on one side is being transferred to another where it becomes the source of, again, an action or activity, depending on its interpretation, where that response is not necessarily predetermined. The interpretation of the information being exchanged (or: the knowledge being transferred) is not unconditionally unambiguous. It is influenced by the set of connotations the recipient has, which in turn depends on the functional context, defining in which respect and with which mental capacity the recipient views the information, and the cultural context, providing the wider sphere of the whole of applicable connotations. (While this situation can arise with collaborating autonomous agents, it is more likely and more problematic for teams of human developers and their IT support.)

It is crucial here that both sides agree upon a common set of connotations, through a combination of fixing it in a glossary when setting up a collaboration, and aligning it dynamically during the run time of the collaboration. In some cases, glossaries must be expanded to add missing connotation "overtones", or to soften existing and misleading overtone connotations within the social (and less frequently political or business) culture pertaining at one or more of the collaborators.

In the next section, we consider issues affecting such human teams, and to a lesser extent, those affecting their IT support frameworks or their eventual product.

# 3 Knowledge management: the externalization, internalization and transfer of knowledge

Knowledge management is understood as the organization of the utilization of explicit, implicit, tacit and collaborative knowledge in and between enterprises, organizations, and institutions. Issues relating to the transfer of knowledge in the context of business practice have been identified for example in [5]. Difficulties

inherent to knowledge management in interorganizational collaborations have been taken up in [9], while the considerations there were mainly focused on non-technical challenges. The following sections present a discussion of the codification problems related with the transfer of knowledge in collaborations.

In a single organization/culture/community, practical knowledge (and ritual) are each given meaning by a predefined set of constructs and attitudes. Many of these are kept implicit. While in a single society/community, explication in a literal sense is desirable as insurance against social (in a broad sense) change and the effects of time, explication via decodification (and possibly recodification on the other end) is absolutely needed for collaboration across major cultural (in a broad sense) boundaries, where the context and the implicit structures are lacking. In its absence, shared work toward common goals is only achieved in the unlikely event of multiple parties pursuing closely aligned goals for fortuitously coincident rationales. But this is an unacceptable risk when multiple partners engage in a collaborative project or process.

Thus the primary drivers of codification are standardization and risk, and the main problems are cultural incoherence, miscodification of tacit knowledge, and loss of knowledge:

- 1. Within a single organization, in a single cultural setting, with a single project team, or tightly coordinated teams, the main risks are (1) improper codification of knowledge and practice aimed at standardization and quality control/assurance, and (2) risks due to change turnover in management, key personnel, information technology and other tools, and changes in standards, statutes and regulations, business processes and practices, and so on. The tacit and implicit knowledge encoded in the interaction between human agents and tools (and among tools) is especially vulnerable to changes on either side of the exchange.
- 2. In a distributed project, still within a single cultural and organizational setting, additional risks include different understandings of processes and tools. Also, if key personnel and domain experts are associated with one of the teams, the understandings in that relationship have to be externalized if other teams require that specialized knowledge.
- 3. In a multi-organizational context, teams in different organizations will have different organizational cultures, different understandings of the relationship between technical and management teams, and possibly work in a different platform/tool environment, including but not limited to IT support.
- 4. In a multi-cultural environment, there is in addition the usual difficulty with different connotations, and

often different denotations, of certain actions, decisions, and statements, particularly if elliptical, partial, or non-committal, and different customs and interpretations for physical gestures and movements.

In cross-organizational and cross-cultural contexts, a single perspective may not suffice. Multiple perspectives and/or filters may be needed in order to assure a common or overlapping understanding, whether through provision of different intermediating routes to a common connotation, or actually by creation of distinct connotations that interact with existing culture and perspective to provide a shared or at least mutually comprehensible understanding. These multiple perspectives will be most important for business, project and process narrative and its underlying cultural fabric, but may at times be important even for more structured artifacts.

Applying the concept of the semiotic process now to the transfer of knowledge in a collaboration, there is a need to extend every denotation, i.e., codification of a thing or a concept, by appropriate connotation of the contextual sphere in accordance with a specific perspective applied, in order to ensure proper understanding of the concept by the interpreter (cf. [7], [8]). Explication then is achieved by decodification. Connotation can be appended to a denotation in a generic way, or by means of linking the denotation to a specific ontology. This affects the externalization of knowledge on the originating side, its transfer and the internalization on the destination side.

The connotative sphere of a sign, for example the escalator pictogramme mentioned in section 2, is in many cases constituent for its proper understanding, especially if it is a non-verbal/non-textual sign. A nomad in the desert who has never seen an escalator nor has any knowledge of such a thing, when getting to see the pictogramme would not connect any denotation with it, neither with its function. The semiotic process – if there is any – will not lead to understanding. (The fact of the perception of signs without any or with only rudimentary factual or mental connotation is an issue worthwhile to further investigate, though – in particular with regard to its stimulating potential for the generation of knew knowledge.)

### 4 The role of semantic technologies

The transfer of knowledge, as shown in the previous sections, requires appropriate formal representation of knowledge as a basis. Formal representation comprises not only a certain terminology (or vocabulary), but also syntactic structure and semantic rules, and in the end could include also pragmatic references. It goes down to

the proper encoding of information within coding schemes that are generally embedded in cultural context (section 2), and particularly are specific to a given domain of knowledge. Codes consist of a set of conventions, hence are culturally co-variant and subject to change as context changes over time. Furthermore, knowledge transfer in collaborative settings within procedural practices, such as business, puts relevant challenges on bior multilateral synchronization of understanding (section 3). In [9] we argue that the codification of collaborative knowledge is a prerequisite to its transfer. Technological support for the externalization, transfer and internalization of knowledge is provided by shared infrastructures, process models, and semantic technologies. Semantic technologies, while very much restricted to verbal/textual representation of information, these days are considered the most promising approach to the challenge of formal representation of knowledge. Their role in crossorganizational collaborations shall be considered in this section.

Semantic technologies provide the means to develop ontologies for practical use. The general purpose is to enrich information with meaning, by making use of appropriately defined vocabularies within wellconstructed syntactic and semantic frameworks. For the field of business, the Object Management Group (OMG) recently have presented their specification of 'Semantics of business vocabulary and business rules' SBVR [10]. It adds to existing business ontology specification frameworks like OASIS Standard UBL, UDEF, or ebXML. Like these it is targeted at business vocabularies and rules, and does not comprise for example business processes. It supports the externalization of knowledge making use of verbal representation. It does not offer means to deal with knowledge objects that are represented non-verbally. For the purpose of knowledge transfer related to business transactions and its automation, this is sufficient. Out of its scope is the integration of business processes at the pragmatic level, and the facilitation of the management of non-verbal/-textual knowledge involved in collaborative action. Thus it is in support of the transfer of collaborative knowledge, while being limited though as far as non-verbalized knowledge is excluded. This is a basic issue to be noted.

Within these limits of current semantic technologies, the question of ontology mapping in collaborations needs being addressed. Collaboration means that two or more organizations mutually connect some of their activities based upon their established processes. This can be done by integration of their existing processes, at the risk of losing flexibility, but with the option of gaining benefits through automation; or by coupling processes through less automated interfaces. In either case, there is significant need to transfer knowledge between the collaborating entities. Each of these may have its knowledge base, which may be available in machine-interpretable formal representation, but need not be necessarily complete or consistent. So each one owns an explicit or implicit ontology being, perhaps partly, used in the collaboration, but also in other operations and processes that are not directly affected. Consequently, the underlying ontologies of collaboration partners are being practically mapped through daily collaborative practice, while each collaborating unit will generally keep their own one for continued use in other operations.

IT applications in support of the collaboration will build upon these ontologies. Knowledge transferred will make use of the vocabulary and the referencing schemes represented there. Hence a need arises for their alignment. This goes beyond just the implementation of unambiguous relations between, for example, product numbers or document ID's at the formal level. It affects as well the use of denotations at the content level.

From a business integration view, these issues have been dealt with in [12], resulting in the provision of a solution offering semantic synchronization services for ontologies, called the Ontologies-based Reconciliation for Business Integration - ORBI Ontology Mediator. The system resolves the problem of disambiguation in ontology mapping by making use of user-generated ratings and contexts for the synchronization of semantic references. It thus facilitates evolving context-sensitive mapping which is driven by users. An issue with practical application of this system in a collaboration is the need to convert knowledge bases existing at all partners into ontologies. As these knowledge bases may be built upon different standards or on proprietary non-standards, this conversion effort can become a significant challenge. This is another issue to be noted.

For intra-enterprise collaboration, semantic technology services have been suggested in [1], based upon the Activity Context Ontology ACO. They are limited in the number and scope of collaboration concepts the ontology is build from. This leaves much of the difficulty with setting up a comprehensive ontology for collaboration to the extraction of context information, which is an issue similar to the one identified above with the ORBI Ontology Mediator.

A third suggestion for the collaborative capturing of knowledge in ontologies has been provided in [5]. It is aimed at the capture of domain expert knowledge from the Semantic Web. Based on concept maps, a prototype of a Collaborative Ontology Environment COE for the construction of ontologies as formal representations of distributed knowledge bases is described.

Overall, semantic technologies have to be considered a promising approach to the transfer of knowledge in collaborations. Knowledge that can be formally

represented in ontologies, and thus becomes machineinterpretable, can be managed either in shared ontologies or by making use of ontology alignment techniques. At the time being, however, they appear to provide little support to the dealing with knowledge which can not, or not easily, be formally represented verbally/textually. On the other hand, there is also certainly a great deal of work -some centuries old-on translating between pairs of notations, diagrams, encodings and/or models in the mathematical or related domains, even though, in some cases, the correspondence is not total or is modulo some equivalence relation. Standard examples include the correspondence between elements of a power set and characteristic functions, between Boolean matrices and directed graphs, between regular expressions and finite state automata, between probability distributions and moment generating functions, and between invariants and symmetry groups (the Noether correspondence). A trivial software development example would be the correspondence between sequence and interaction diagrams in UML [2]. Where this is important for collaboration or collaborative development, this can easily be added, as long as relevant "parsers" are available.

Nonetheless, the problem of converting existing knowledge into suitable ontology representation puts another challenge on the management of knowledge in collaborations.

### 5 Conclusions and further work

This paper presents an investigation of the management of knowledge in collaborative environments from a semiotic angle. Besides the non-technical challenges related to the sourcing and use of knowledge in collaborations, the need to codify knowledge for the purpose of making it available to and transferable between collaborators raises the problem of its formal and machine-interpretable representation. Our considerations on the role of semantic technologies brought about a number of technical challenges that are still to be resolved. They will be addressed in our further work.

One of these is ontology alignment and semantic synchronization in collaborations. Promising approaches in this respect will have to be further engineered by applying "knowledge testing" – an interaction with selected individuals to determine the effectiveness of a selected encoding. Further, an important task of knowledge engineering in this context will be to identify efficient ways of using existing knowledge bases. And longer term work shall be dedicated to the problem of formal representation of non-textual knowledge.

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# Limitations of the Information Security Management System Assessment Approaches in the Context of Information Security Policy Assessment

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#### ABSTRACT

Organizations develop information security policies to provide direction in implementing their information security management programs. These information security policies require assessment relative to the security assurance requirements of the organization to maintain its capability to handle security risks according to evolving business objectives. This paper provides a brief literature review on information security policy assessment by first providing an overview on the general considerations and mechanics for assessing information security policies. This is followed by a short discussion of existing research and industry best practice on assessment approaches commonly utilized for information security management systems. The review evaluates information security assessment approaches based on the defined assessment considerations and mechanics under two main categories: the process-based assessment methods and the product-based assessment methods. It is shown that there are limitations on the literature on information security assessment when reviewed in the context of information security policy assessment.

#### 1 General Considerations for Information Security Policy Assessment

Information security policies define the goals, responsibilities and security control requirements that are continually reassessed and updated based on evolving corporate business and risk management objectives. Information security policies may be presented as a collective set of organizational statements consisting of an overarching high level strategic statement of security assurance goals, a lower level of operational policies and procedures and a more detailed technical layer of IT application and system security policies. The acknowledged drivers for information security policy management include the corporate requirements for ICT risk management and governance and regulatory compliance, and the need for coordinated and integrated policies for coherent security management.

Effective information security policy management requires policy review activities in addition to policy development and implementation. The International Standards Organization standard Information technology -- Security techniques -- A framework for IT security assurance -- Part 1: Overview and framework ISO/IEC15443-1 defines security assessment as "the verification of a security deliverable against a security standard using the corresponding security method to establish compliance and determine the security assurance". The ISO/IEC15443-1 further defines that the target object of a security assessment may be an information technology security product system, service, process, or environmental factor such as personnel.

The elements of any assessment activity usually consist of a defined purpose and method of measurement which includes the metrics approach. The purpose or requirement for assessment must define the method of measurement and the metrics approach. As management of information security policies require both the establishment of a policy development process and the effective implementation of the product set of security policies, a security policy assessment method may be classified as either a process-based approach if the primary assessment objective is business process improvement, or a product-based approach if effectiveness of security policy implementation is the primary concern.

In addition, the assessment should consider the following characteristics based on the derived definitions and drivers for security policies discussed earlier:

- Risk-based development policy development process should be based on business and/or organizational requirements to manage risks;
- (2) Security policy structure product set of security policies, practices and procedures should be coordinated and integrated and implemented at different levels;
- (3) Cost efficiencies security policies should be balanced against both cost efficiencies and benefits; and
- (4) Review and assessment development process should facilitate policies to be continually reassessed and updated to address evolving risks.

#### 1.1 Process-based Assessment

The major driver for utilizing process-based assessment is the requirement for business improvement drawn from the corporate need for cost-cutting in operations and improving business performance and productivity. Such requirements are usually brought about by organisational changes in corporate structure, strategic business direction and overall corporate objectives. To address the requirement for security policy assurance through process improvement, the mechanics for process-based assessment involve the process quality elements of consistency, repeatability, predictability of outcomes and continuous optimization. These quality elements are the main assessment considerations defined in the capability maturity models initially developed for software development.

#### **1.2 Product-based Assessment**

The other major focus of security policy assessment is on the effectiveness of the security policies as internal controls for achieving and maintaining organizational security assurance. In this perspective, the main considerations for product-based assessment are the policy quality elements that address the need for security policies to be based on business and/or organizational requirements to manage risks (business alignment); coordinated and integrated and should be implemented at different levels (integrated policy structure); and balanced against both cost efficiencies (cost efficiency).

# 2 Assessment Approaches in Information Security Management

Information security assessment are required to maintain organizational security assurance. Although vast majority of organizations conduct security audits, the tools and methods of assessment used for security is far from universal. Depending on the business objective for security assessment which is commonly for compliance and certification purposes, the traditional methods of assessment involve auditing of security technologies and controls against checklists provided by industry standards and best practices. These checklists of controls have progressed to include elements that define the state of maturity of processes as adapted from the assessment approach of the capability maturity model for developed by the Software Engineering Institute for evaluating software development.

#### 2.1 Traditional Assessment Methods

The multipart standard ISO/IEC 15408, also known as the Common Criteria, (CC) is one of the earliest tools used for security assessment. The CC defines the criteria to be used as evaluation basis for the security properties of IT products and systems and is mainly used as a guide for the development of products and systems. The CC guidelines provide checklists of requirements that are applied to IT security measures in hardware, firmware and software implementation. Essentially, the evaluation process provides a confidence level that the security functions of the products and systems meet the security assurance requirements.

The Information Protection Assessment Kit (IPAK), another early assessment tool, is used to measure the state of the information protection program of an organization. It presents an assessment criteria checklist that contains basic categories providing internal controls statements for compliance. Other similar but more prominent assessment checklists are provided by the industry and best practice standards.

Among the most widely used information security management standards are the ISO/IEC 27001

Information technology - Security techniques Information security management systems Requirements, the National Institute of Standards and Technology (NIST) Generally Accepted Principles and Practices for Securing Information Technology Systems Special Publication 800-14 and the Information Technology Infrastructure Library Best Practice for Security Management (ITIL). Also used is the governance standard COBIT Control Objectives Management Guidelines. These standards and best practice guidelines provide general checklists for security auditing. Suggestive definitions and characteristics for consideration in developing security policies are also provided as reference for policy audit.

#### 2.2 Capability Maturity Assessment Methods

The maturity assessment model defines a 5-level maturity categorization to assess capability based on process maturity and uses metrics to measure process and productivity of the software development life cycle. The maturity assessment model was adopted and adapted for information security through assessment checklists presented by industry standards such as the Information technology-Systems Security Engineering-Capability Maturity Model SSE-CMM (ISO/IEC 21827) and the Federal Information Technology Security Assessment Framework (NIST\_2000) used to evaluate the information security management system within the organization. Also used is the governance standard COBIT Control Objectives Management Guidelines. COBIT Maturity Models (COBIT).

Table 1 presents a summary of the checklist-type of assessment provided by the maturity assessments in the industry standards.

| Levels  | NIST 2000  | ISO/IEC                   | COBIT   |
|---------|--|---------------------------|---|
|         |  | 21827                     |   |
| Level 1 | policy<br>developed and<br>implemented                       | not<br>performed          | <b>Non-existent:</b><br>There is no recognition of<br>the need to establish a set of<br>policies  |
| Level 2 | documented<br>procedures<br>must be in place                 | performed informally      | Initial/Ad Hoc:<br>Policy development are ad<br>hoc and driven by issues  |
| Level 3 | procedures and<br>controls must be<br>implemented            | well defined              | <b>Repeatable:</b><br>Policy development is left<br>to the discretion of the<br>managers  |
| Level 4 | procedures and<br>controls must be<br>tested and<br>reviewed | quantitatively controlled | <b>Defined process:</b><br>Management has<br>developed a framework for<br>policy development  |
| Level 5 | procedures and<br>controls must be<br>fully integrated       | continuously<br>improving | Managed and<br>Measurable:<br>A complete set of policies<br>has been developed,<br>maintained and<br>communicated<br>Optimised:<br>The control environment is<br>aligned with the strategic<br>management framework<br>and is regularly reviewed,<br>updated and improved |

Table 1 Levels of Maturity Assessment Models

The levels of the maturity assessment checklist in Table 1 may be considered to be addressing some of the process quality elements to an extent. However, there is a lack of presentation on the measurement method and metric approach which renders the assessment approach inadequate for assessing overall organizational security posture. The checklist approach is usually employed for high-level security audit for purposes of meeting certification against the standard or meeting compliance requirements.

# **3** Evaluating Assessment Approaches in the Context of Information Security Policy Assessment

The relevant factors in evaluating the existing assessment approaches in the context of information security policy assessment are: first the nature of assessment based on the requirement (process-based or product-based) and second the set of quality elements according to the nature of assessment. In Table 2, both the traditional and maturity assessment methods are checked against every quality element required by the nature of the assessment. Each of the assessment methods is also checked against the factors such as the method of measurement and metrics approach as part of each of the assessment approach. A check means the assessment method provides a means to address the quality element requirement either through the presence of a checklist method of assessment or a method of measurement which includes a metrics approach.

| Nature of assessment | Quality<br>elements               | Tradition<br>m | al assessment<br>ethods                 | Capability maturity<br>assessment methods |   |  |  |
|----------------------|-----------------------------------|----------------|---|---|---|--|--|
|                      |                                   | checklist      | method of<br>measurement<br>and metrics | checklist                                 | method of<br>measurement<br>and metrics |  |  |
| Process-             |                                   |                |   |   |   |  |  |
| based                | Consistency                       |                |   | · ·                                       |   |  |  |
|                      | Repeatability                     |                |   | ~   |   |  |  |
|                      | Predictability<br>of outcomes     |                |   | 1   |   |  |  |
|                      | Continuous<br>optimization        |                |   | 1   |   |  |  |
| Product-             |                                   |                |   |   |   |  |  |
| based                |                                   | 1              |   |   |   |  |  |
|                      | Business<br>alignment             | -              |   |   |   |  |  |
|                      | Integrated<br>policy<br>structure | 1              |   |   |   |  |  |
|                      | Cost<br>efficiency                | 1              |   |   |   |  |  |

Table 2 Evaluation of Assessment Approaches Matrix

Based on this presentation, it is shown that there are limitations on the traditional and capability maturity assessment methods when reviewed in the context of information security policy assessment as formal measurement methods have not been provided. The traditional assessment tools are used mainly in the conduct of a security audit to assess the extent of security implementation in an organization and not necessarily the security posture of the organization. These tools, using the checklist type of assessment do not define levels of maturity by which an organization can assess itself thus leaving a gap by which to base improvement. The lack of a progressive assessment scheme in traditional assessment methods presents a challenge to the organization in implementing an improvement approach to escalate to a higher level of maturity pertinent to their organizational policy processes, much less their policies structures. On the other hand, maturity assessment approaches concentrate attention on the process itself, usually losing sight of the product that the process is

producing. By itself, the capability maturity assessment approach will not provide sufficient assessment results to provide an understanding of the effectiveness of the security policies.

#### 4 Conclusion and Recommendation

It is concluded that the current literature on security management assessment greatly utilizes the processcentric method of assessment based on the maturity assessment model and that there is limited literature on other aspects of assessment such as product-centric methods. The main contribution of the paper is that it presents a comparison of the assessment methods in the context of security policy assessment to facilitate policy review and development as part of information security policy management. The paper provides a basis for comparing assessment approaches to facilitate method selection for assessing security policies based on the required nature of assessment . Related future work that can be pursued may involve the development of a framework for security policy assessment.



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