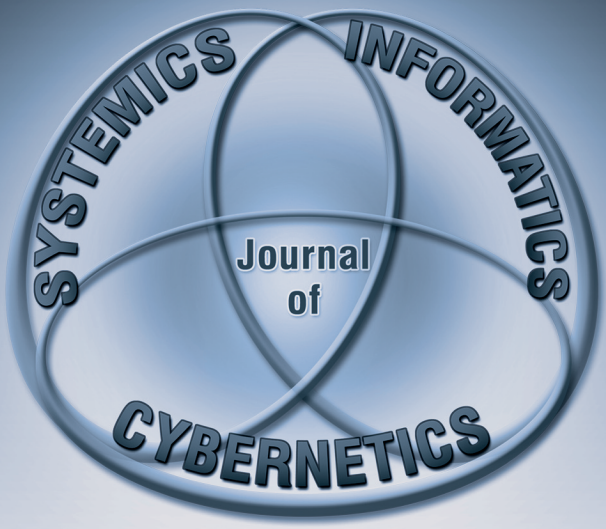


Journal of Systemics, Cybernetics and Informatics

SPECIAL ISSUE

Invited Papers of the Plenary Keynote Speakers at the IIIS 2014 Conferences

GUEST EDITOR
Jeremy Horne

SPONSORED BY
The International Institute
of Informatics and Systemics

Volume 12 Number 5 2014

Journal of

Systemics, Cybernetics and Informatics

Volume 12 ♦ Number 5 ♦ 2014

Sponsored By
The International Institute of Informatics and Systemics
2014

ISSN: 1690-4524 (Online) pp200302MI1469

Journal of
Systemics, Cybernetics and Informatics

Volume 12 ♦ Number 5 ♦ 2014

www.iiisci.org/Journal/SCI

CONTENTS

Optimizing Ship Classification in the Arctic Ocean: A Case Study of Multi-Disciplinary Problem Solving 1
Rahmes, Mark; Pemble, Rick; Fox, Kevin; Delay, John (United States)

Inter-Disciplinary Inquiry-Based Science Experiences for the 21st Century 7
Lunsford, Suzanne; Nguyen, Phuong Khanh Quoc; Spradlin, Corrie (United States)

Fostering Interdisciplinary Collaboration to Improve Student Learning 10
Styron Jr., Ronald A.; Styron, Jennifer L. (United States)

A Discipline-Independent Approach to a Higher Cognitive Pedagogy 16
Russell Jay, Hendel (United States)

Anticipating Serendipity. Preparing for the Unexpected. 22
Thomas J., Marlowe (United States)

An Inter-Disciplinary Language for Inter-Disciplinary Communication: Academic Globalization, Ethos, Pathos, and Logos 27
White, Marta Szabo (United States)

Towards a General Methodology for Second-Order Science 33
Müller, Karl H. (Austria)

Cross-Cultural Communication Training for Students in Multidisciplinary Research Area of Biomedical Engineering 43
Hashimoto, Shigehiro (Japan)

The Smarter Planet: Built on Informatics and Cybernetics 49
Fred A., Maymir-Ducharme; Lee A., Angelelli (United States)

Casting a Wide Net for Innovation: Bringing Interdisciplinary Collaboration to Real World Problems 55
Cherinka, Robert; Prezzama, Joe (United States)

Knowledge Integration and Inter-Disciplinary Communication in Action Research 60
Heidi Ann, Hahn (United States)

C-ITS as Multidisciplinary Area with High Demand on Telecommunications Solutions 68
Zelinka, Tomas (Czech Republic)

Forging Industry-Academic Alliances 73
Woodside, Joseph M. (United States)

Academic Ethos, Pathos, and Logos. Research Ethos 76
Callaos, Nagib; Callaos, Bekis (United States)

Realizing a Disciplinarian State of Being from an Interdisciplinary Approach or an Interdisciplinarian State of Being from Disciplines 96
Edwards, Matthew E. (United States)

A Philosophy of Learning 103
Horne, Jeremy (United States)

Optimizing Ship Classification in the Arctic Ocean: A Case Study of Multi-Disciplinary Problem Solving

Mark Rahmes
Rick Pemble
Kevin Fox
John Delay

Harris Corporation,
Government Communications Systems
Melbourne, Florida 32904

ABSTRACT

We describe a multi-disciplinary system model for determining decision making strategies based upon the ability to perform data mining and pattern discovery utilizing open source actionable information to prepare for specific events or situations from multiple information sources. We focus on combining detection theory with game theory for classifying ships in Arctic Ocean to verify ship reporting. More specifically, detection theory is used to determine probability of deciding if a ship or certain ship class is present or not. We use game theory to fuse information for optimal decision making on ship classification. Hierarchy game theory framework enables complex modeling of data in probabilistic modeling. However, applicability to big data is complicated by the difficulties of inference in complex probabilistic models, and by computational constraints. We provide a framework for fusing sensor inputs to help compare if the information of a ship matches its AIS reporting requirements using mixed probabilities from game theory. Our method can be further applied to optimizing other choke point scenarios where a decision is needed for classification of ground assets or signals. We model impact on decision making on accuracy by adding more parameters or sensors to the decision making process as sensitivity analysis.

Keywords: Game Theory; Detection Theory; Decision Making; Fusion

1. INTRODUCTION

The environment is an important part of the Intelligence Community agenda. The Intelligence Community is involved in this work, and involvement is important for citizens of the United States and the world. The Intelligence Community's job is to ensure that senior policymakers and military commanders have objective information that will allow them to make better decisions. Through collection and analytic effort, intelligence reports give our country's leadership insight into how events in all parts of the world will unfold and how these events will affect our national security. Environmental trends, both natural and man-made, are among the underlying forces that affect a nation's economy, its social stability, its behavior in world markets, and its attitude toward neighbors. The environment is one factor. Environmental degradation, encroaching deserts, erosion, and over farming destroy vast tracts of arable land. This forces people from their homes and creates tensions between ethnic and political groups as competition for scarce resources increases. There is an essential connection between environmental degradation, population growth, and poverty that regional analysts must take into account [2].

National reconnaissance systems that track the movement of tanks through the desert, can, at the same time, track the movement of the desert itself and see the sand closing in on formerly productive fields or hillsides laid bare by deforestation and erosion. Satellite systems allow assessment of the magnitude and severity of damage. Adding this environmental dimension to traditional political, economic, and military analysis enhances the ability to alert policymakers to potential instability, conflict, or human disaster and to identify situations which may draw in American involvement. Some events have already dictated that environmental issues are included in our intelligence agenda. When Moscow initially issued misleading information about the accident at the Chernobyl Nuclear Power Plant, U.S. leaders turned to the Intelligence Community to assess the damage and its impact on the former Soviet Union and neighboring countries [2].

The U.S. Coast Guard's (CG) value to the nation resides in its proven ability to protect those on the sea, protect the United States from threats delivered by sea and protect the sea itself. Its unique authorities, capabilities, competencies and partnerships as a military, law enforcement, regulatory and humanitarian service are central to that value proposition. The CG is recognized worldwide for its ability to execute these diverse maritime missions over vast geographic areas and under the most challenging and demanding conditions [7].

As the CG prepares for the future, the emerging maritime frontier of the Arctic is significantly expanding the operating area. Last September 2013 it was observed that the Arctic had the lowest sea ice extent in recorded history, and there are vast areas of open water where there used to be ice. Activity in the most remote reaches of Alaska continues to evolve and grow, including planned drilling operations in the Chukchi and Beaufort Seas, foreign tankers using the northern sea routes which transit through the Bering Strait and Sea, and small cruise ships pressing even further into the Arctic. As the receding ice invites increased human activity in commercial and private ventures, there is increasing demand for the Coast Guard to

ensure the safety, security and stewardship of the nation's Arctic waters [7].

The circum-Arctic region and Outer Continental Shelf area ranks second behind the Gulf of Mexico for volume of resources. Sovereign and industrial activities will continue to evolve around access to an abundance of resources. These resources include an estimated 13 percent of the world's undiscovered oil, 30 percent of undiscovered gas, and some one trillion dollars worth of minerals including gold, zinc, palladium, nickel, platinum, lead, rare-earth minerals, and gem-quality diamonds. As Arctic ice recedes and maritime activity increases, the Coast Guard must be prepared to administer and inform national objectives over the long-term. The United States is an Arctic nation, and the Coast Guard supports numerous experienced and capable partners in the region. The aim of this strategy is to ensure safe, secure, and environmentally responsible maritime activity in the Arctic. This strategy establishes objectives to meet this aim and support national policy [7].

There are three strategic objectives in the Arctic for the U.S. Coast Guard. Improving Awareness: Coast Guard operations require precise and ongoing awareness of activities in the maritime domain. Maritime awareness in the Arctic is currently restricted due to limited surveillance, monitoring, and information system capabilities. Modernizing Governance: The concept of governance involves institutions, structures of authority, and capabilities necessary to oversee maritime activities while safeguarding national interests. Limited awareness and oversight challenge maritime sovereignty, including the protection of natural resources and control of maritime borders. Broadening Partnerships: Success in the Arctic requires a collective effort across both the public and private sectors. Such a collective effort must be inclusive of domestic regulatory regimes; international collaborative forums such as the Arctic Council, International Maritime Organization (IMO), and Inuit Circumpolar Council; domestic and international partnerships; and local engagements in Arctic communities focusing on training and volunteer service [7].

An oceanic trade route across the Arctic from the North Atlantic to the North Pacific would represent a transformational shift in maritime trade, akin to the opening of the Panama Canal in the early 20th century. An Arctic marine highway would cut existing oceanic transit between Europe and Asia by an estimated 5,000 nautical miles [7].

Economic factors (e.g., unemployment rates, prices for food, such as bread, or fuel), Political factors (freedoms, type of government), Religious factors (type of religions, religious tensions) combined with trend information such as sentiment analysis on social media, open source data, news, etc. can provide indicators of areas undergoing stress or at risk. An attempt to predict the likelihood of reaction to a future event will be based on correct situation analysis. Efforts to combine the information required for these predictions are time consuming and labor intensive. The availability of open source social media information and implementation of artificial intelligence (AI) methodologies makes this problem tractable. Our GlobalSite system, shown in Figure 1, can be used as a method for decision making and reduce cost of analyses.

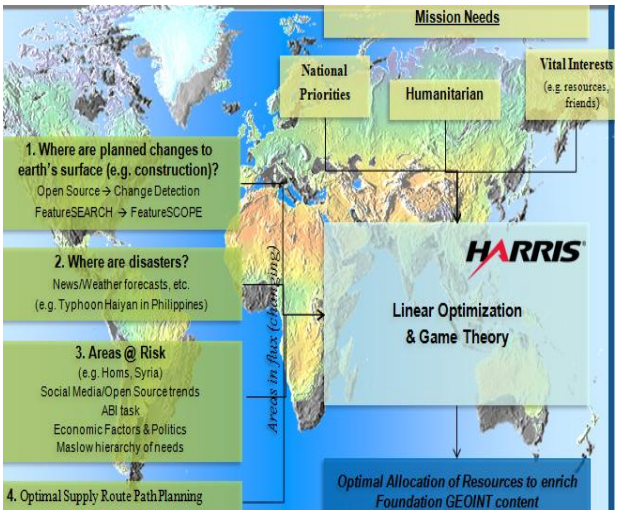


Fig. 1. System Overview

2. ANALYTIC HIERARCHY PROCESS

The Analytic Hierarchy Process (AHP) is a multi-criteria decision-making approach. The AHP is a decision support tool which can be used to solve complex decision problems. The AHP has attracted the interest of many researchers mainly due to the mathematical properties of the method and the fact that the required input data are easy to obtain. It uses a multi-level hierarchical structure of objectives, criteria, sub criteria, and alternatives. The pertinent data are derived by using a set of pair wise comparisons. These comparisons are used to obtain the weights of importance of the decision criteria, and the relative performance measures of the alternatives in terms of each individual decision criterion. If the comparisons are not perfectly consistent, then it provides a mechanism for improving consistency [18].

Hierarchical game theory can be used to solve for the best strategy for decision making in complex problem solving. Hierarchical game theory can determine cooperating capacity between hierarchies and detect the best united strategy. This can provide a powerful method of resource allocation and asset planning in order to maximize a player's response [8]. Figure 2 shows the hierarchical, game structure for our example. All of these hierarchies are part of the overall player's capability to compete with other players. The four hierarchies are: sensors, ship classes, organizations, and competing nations. In our example we can model uncertainty of sensor detection to determining ship classification and model the probability of a nation verifying ship reporting accuracy. This information is then used to compete with other nations or players for situational awareness of the Arctic region. A feedback loop is used to model sequential time periods as updates are observed [14].

This framework solves for controlling ability in groups and the hierarchical trait in command and control. Thus, to enhance independent decision-making in lower decision-makers and make decision-making between the upper and the lower decision-makers not only have clear hierarchies, but also interact and optimize each other. Sequentially, perfect effects can be obtained with a hierarchy model. [8].

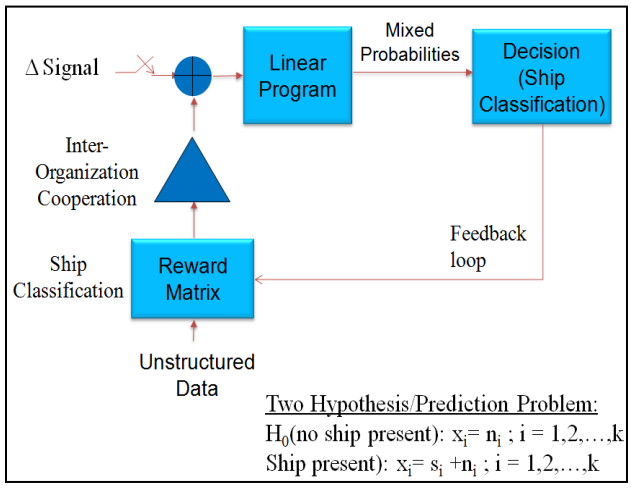


Fig. 2. Model Process Flow

The organizations determine the missions. The missions are to be carried out by the organizations. The sensors are used to carry out the missions. Our example consists of organizations, sensors [5], ship classes, and nation players. Figure 3 shows the elements of each hierarchy.

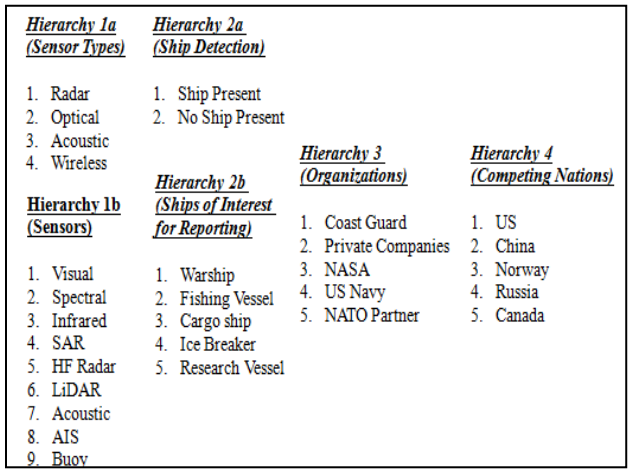


Fig. 3. Hierarchies and Elements

The goal is to maximize the decision function. The overall performance of the decision is based on several levels of hierarchical decisions. Our example starts with the decision to optimize ship classification decision to verify ship reporting accuracy versus other nation players. Cooperation between organizations is modeled using multi-player Prisoner's Dilemma in our solution [10]. The choice of sensor to use is based on availability. The ship classes are based on real world data. Each level of hierarchy has an impact on the overall ability for a country or blue player to compete on a global basis. Cooperation is less likely to emerge in a large group than a small group. The iterated Prisoner's Dilemma (PD) game has been used extensively in the study of cooperative behaviors in social and biological systems. The N player PD game is realistic for modeling the cooperation strategies [22].

However, in the real world, individual rational actions are not always taken. In our example, responsible organizations are given incentives to cooperate so that their action can take a better action in the international game so that the blue player can best compete [19]. Results of an open competition are well explained by cognitive hierarchy (CH). In many games it boils down to predicting how deeply other agents in the game will be reasoning. An agent that does not reason enough risks being exploited by its opponents, while an agent that reasons too much, may not be able to interact productively with its opponents [21].

We let the objective function be $F = (F_1, F_2)$ where F_1 could be the blue player. We let x_1 be the decision maker's choice for blue. We let h_{11} to h_{1m} be the lower hierarchical decision maker's response. The objective function for blue's lower decision makers is f_{ij}. We let S_1 be the feasible sets for variable x_1. S_1 depends on x_1 and h_{11} to h_{mj}. The lower decision-maker can modify the upper decision maker's mind according to the actual status [8].

In our example, there are several resource management stages or hierarchies as shown in Figure 4. These stages include information needs, collection objectives, and observables. Our example serves as a method to enhance situational awareness for making best decisions concerning the status of the Arctic region. Situational awareness is used as critical information for activity based intelligence for decisions for allocating resources. Resource management is a component of situational awareness is to translate the decision maker's information needs to real world actions. The orchestration of sensors and identification of sources to produce relevant input for a fusion process is referred to as resource management. Resources are the technical means employed to gather essential data [9]. Operations Research is a branch of mathematics that studies decision making to obtain the best decision. Game theory can help determine the optimal investment strategy [19].

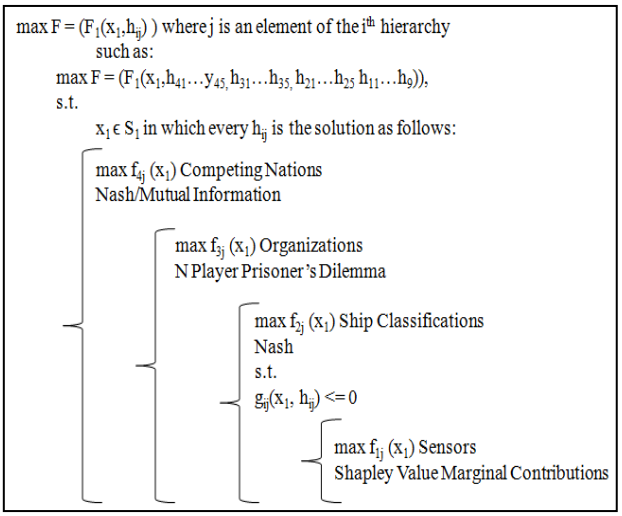


Fig. 4. Hierarchical Structure

Generally, players may not possess full information about their opponents. In particular, players may possess private information that others should take into account when forming expectations about how a player would behave. To analyze these interesting situations, a class of games with incomplete information was created as use case scenarios (i.e., games where at least one player is uncertain about another player's payoff function) which are the analogue of the normal form

games with complete information similar to Bayesian games or static games of incomplete information [17].

Hierarchy game theory offers important insights and demonstrates superiority of cooperation over competition. Game theory models the heuristics people use in managing their conflicts and helps to explain why rational decisions often miss opportunities for mutual gain [12]. Imperfect information may still be useful to help make decisions. Opponent modeling works by observing the opponent's actions and building a model by combining information from a pre-computed equilibrium strategy with the observations [3]. Cognitive hierarchy is important because it predicts the effect of group size which is not predicted by the Nash equilibrium [1].

3. INFORMATION FUSION

Game theory is the study of strategic decision making. It is the study of mathematical models of conflict and cooperation between intelligent rational decision-makers and is often thought of as an interactive decision theory. It has been applied to economics, political science, psychology, logic, biology and other complex issues. Modern game theory began with the idea regarding the existence of mixed-strategy equilibrium in two-person zero-sum games, applied to economics. Later this evolved to provide a theory of expected utility, which allowed mathematicians and economists to treat decision-making with uncertainty. The notion of probabilistic predictions utilizing game theory is critical in practice to many decision making applications because optimizing user experience requires being able to compute the expected utilities of mutually exclusive pieces of data.

We have created a reward matrix of five rows and nine columns. The five rows are the ship classifications as shown in Figure 5. The nine columns are the sensor capabilities values for probability of detection or area under the Receiver Operating Characteristic (ROC) curves (AUC). Other simulations have accounted for games involving more than two players [4]. Determining ship classification which maximizes the a posteriori probability are Nash equilibrium points of the game. The Nash equilibrium points are local maxima have been proven. Relaxation algorithms exist showing efficiency and rapid convergence [8].

	Vis	HS	IR	SAR	HF Radar	LiDAR	Sound	AIS	Buoy
Ship									
No Ship									

	Vis	HS	IR	SAR	HF Radar	LiDAR	Sound	AIS	Buoy
Warship	a11	a12	a13	a14	a15	a16	a17	a18	a19
Fishing Vessel	b21	b22	b23	b24	b25	b26	b27	b28	b29
Cargo Vessel	c31	c32	c33	c34	c35	c36	c37	c38	c39
Ice Breaker	d41	d42	d43	d44	d45	d46	d47	d48	d49
Research Vessel	e51	e52	e53	e54	e55	e56	e57	e58	e59

Fig. 5. Reward Matrix

Maximin equilibrium often is the strategy and is called the Nash theory application of zero or constant sum strategy game [11]. Game theory considers the effect of a player's decision on other decision makers. In many situations, the opponents know the strategy that they are following and what actions are available. The Nash threshold can be used to determine if the player is on the blue or red team. For example, if a reward matrix exists, then the equilibrium point is the one where the reward is the smallest value in its row and the largest number in its column [19].

$$\max_{\text{all rows}} (\text{row min}) = \min_{\text{all columns}} (\text{column max}) \quad (1)$$

This left half of (1) presents the basic applied theory to decision making of our model under uncertainty. For a possible action, one consideration is to choose the "best" worst outcome. The maximin criterion suggests that the decision-maker should choose the alternative which maximizes the minimum payoff he can get. This pessimistic approach implies that the decision-maker should expect the worst to happen. The maximin criterion is concerned with making worst possible outcome as pleasant as possible [19].

The right half of (1) represents minimax regret criterion which uses the concept of opportunity cost to arrive at a decision. The regret of an outcome is the difference between the value of that outcome and the maximum value of all the possible outcomes. For any action and state, there is opportunity of loss or regret. The decision-maker should choose the alternative that minimizes the maximum regret he/she could suffer [19].

Using different weights allowed for choices is to highlight the ability and need for a tool which can be used to allow the user to dial and modify modeled parameters of the reward matrix to model "what if" scenarios. Additionally saving the weights to a file allows for peer review in order to check and validate decisions. Our approach is modeled, so that the process can be repeated to allow for new or higher quality data/information to be inserted into the process to generate updated results [15]. Equation (2) is the translation of a reward matrix to a linear program which can be solved mathematically.

$$\max v \quad (2)$$

s.t.

$$\begin{aligned}
v - a_{11}x1 - b_{21}x2 - c_{31}x3 - d_{41}x4 - e_{51}x5 &\le 0\\
v - a_{12}x1 - b_{22}x2 - c_{32}x3 - d_{42}x4 - e_{52}x5 &\le 0\\
v - a_{13}x1 - b_{23}x2 - c_{33}x3 - d_{43}x4 - e_{53}x5 &\le 0\\
v - a_{14}x1 - b_{24}x2 - c_{34}x3 - d_{44}x4 - e_{54}x5 &\le 0\\
v - a_{15}x1 - b_{25}x2 - c_{35}x3 - d_{45}x4 - e_{55}x5 &\le 0\\
v - a_{16}x1 - b_{26}x2 - c_{36}x3 - d_{46}x4 - e_{56}x5 &\le 0\\
v - a_{17}x1 - b_{27}x2 - c_{37}x3 - d_{47}x4 - e_{57}x5 &\le 0\\
v - a_{18}x1 - b_{28}x2 - c_{38}x3 - d_{48}x4 - e_{58}x5 &\le 0\\
v - a_{19}x1 - b_{29}x2 - c_{39}x3 - d_{49}x4 - e_{59}x5 &\le 0
\end{aligned}$$

$$x1 + x2 + x3 + x4 + x5 = 1$$
$$x1, x2, x3, x4, x5 \ge 0$$

The initial solution for the blue player's mixed strategy in terms of probabilities: **x** = (x1, x2, x3, x4, x5).

4. MODELING AND SIMULATION

When you use a mathematical model to describe reality you must make approximations. The world is more complicated than the kinds of optimization problems that we are able to solve.

Linearity assumptions usually are significant approximations. Another important approximation comes because you cannot be sure of the data that you put into the model. Your knowledge of the relevant technology may be imprecise, forcing you to approximate values in A, b, or c in a linear equation. Moreover, information may change. Sensitivity analysis is a systematic study of how sensitive solutions are to changes in data [6].

Figure 6 shows our sensitivity analysis using several different signal to noise ratios (SNRs). The graph shows the accuracy as a function of the number of parameters (sensors). In our example we have added a signal to one column parameter and Gaussian noise to each parameter in the reward matrix. The SNR, d, is the distance between the means on the two hypotheses, ship class present or not, with a variance normalized to one.

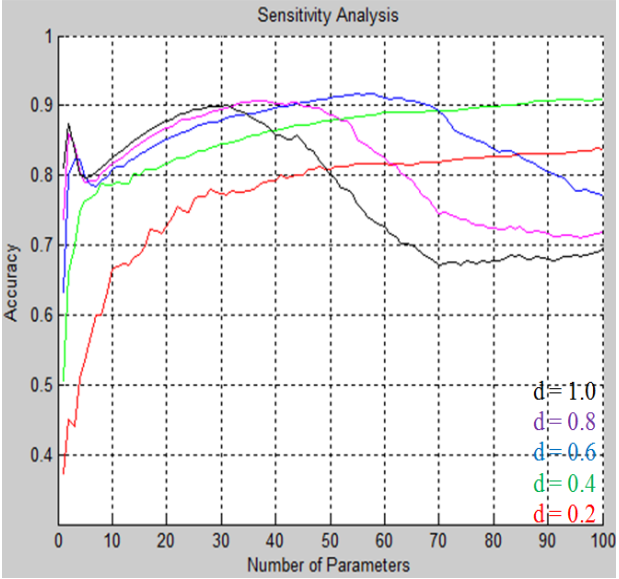


Fig. 6. Linear Programming Sensitivity Analysis

Our sensitivity analysis shows that more parameters are useful when the SNR is low. The analysis also shows that at higher SNR, two or three sensors are enough. The reason for higher accuracy at low SNR is that more information, sensors, helps. The reason for a lower accuracy at higher SNRs is because we have added more constraints as we add more parameters to the linear program. This is similar to principal component analysis where most of the information is contained in the first few variables [13].

If you add a constraint to a problem, two things can happen. Your original solution satisfies the constraint or it doesn't. If it does, then you are finished. If you had a solution before and the solution is still feasible for the new problem, then you must still have a solution. If the original solution does not satisfy the new constraint, then possibly the new problem is infeasible. If not, then there is another solution. The value must go down. (Adding a constraint makes the problem harder to satisfy, so you cannot possibly do better than before). If your original solution satisfies your new constraint, then you can do as well as before. If not, then you will do worse [6].

Figure 7 shows the sensitivity analysis for the Shapley method for calculating accuracy due to marginal contributions based on order [16]. Our Matlab implementation of treating each ship class as a player in a game uses the Shapley value as the probability of choosing a class based on sensor parameters. Our solution currently considers the running average while adding another sensor parameter or column to the reward matrix.

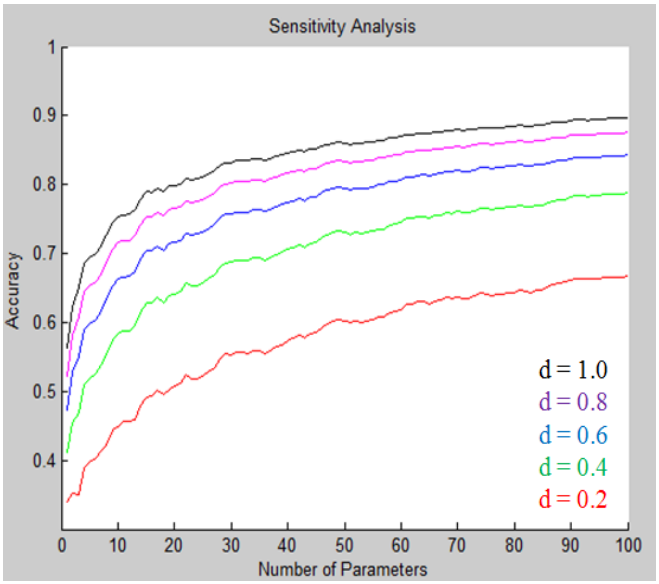


Fig 7. Shapley Sensitivity Analysis

It is interesting to compare the linear programming solution with the Shapley solution. This shows that there is some decision making process for choosing a modeling method. The human brain still needs to be involved in sorting out complex results.

Other work includes an analysis of strategic behavior of countries when there is imperfect verification of an arms control agreement. It provides a framework for determining whether an arms control agreement is desirable, shows which factors are needed for the agreement to be maintained in the absence of third-party enforcers, and develops propositions relating changes in verification capabilities to changes in the likelihood of cheating and the use of verification technology. These propositions yield several paradoxes of information (for example, the better the verification technology, the less often it will be employed). Since the analysis incorporates both simultaneous and sequential moves by the players, it provides new insights into other applied areas as well as game theory [20].

5. CONCLUSION

No decision is ever 100% correct; however, understanding the effects of algorithmic decisions based upon multiple variables, attributes, or factors and strategies with probability assignments can increase the probability for the best decision for a particular situation or event. We discussed a linear programming method for modeling ship verification reporting activities with limited resources. We realize that solution presented is only a guide and is not intended to replace the human brain in decision making. Multi-disciplinary solutions including automated game theory is promising for solving real world strategies and helps an analyst make optimal decisions.

Our contribution in this paper is to combine linear programming, hierarchical game theory with uncertainty modeling in order to plan for activities based on open source intelligence. Our example shows mixed probabilities of ship classification to help a player's situational awareness in order stay knowledgeable about a region of interest. Our solution provides the ability to populate a reward matrix from unstructured big data. We combine a number of technologies for data fusion. Our solution is a multi-use application: course of action planning, resource management, and risk assessment. In the presence of game theory and hierarchical theory, and on the basis of dynamic state attrition-models, our strategy can solve this kind of problem favorably.

Automated processing techniques are needed to augment tactical intelligence-analysis capabilities by identifying and recognizing patterns, weighting them appropriately, providing near real time objective decisions where the user can interact with the information based upon their experiences and knowledge base. GlobalSite is a probabilistic decision solution which allows for users to interact with information in near real time using game theory to provide a reward matrix of best possible outcomes.

Our approach adds computational intelligence to provide the analyst with a decision making capability to reduce time to collect and process data while retaining the information needed to complete the mission analysis. Additionally the probabilities of successfully performing ship reporting verification are filtered by the level of cooperation between participating organizations. Proper execution is critical for attaining the desired impact with respect to other nation players. Our sensitivity analysis models the accuracy as a function of the number of available sensor assets.

6. REFERENCES

[1] Camerer, Colin F., Teck-Hua Ho, and Juin-Kuan Chong. "A Cognitive Hierarchy Theory of One-shot Games." (2002).

[2] Deutch, John. "The environment on the intelligence agenda." *Speech presented to the World Affairs Council.[On-line]. Available:http://www.odci.gov/cia/public_affairs/speeches/archives/ 1996/dci_speech_072596. html* (1996).

[3] Ganzfried, S., and T. Sandholm, "Game theory-based opponent modeling in large imperfect-information games," *International Conference on Autonomous Agents and Multi-Agent Systems (AAMAS)*, 2011.

[4] http://www.innocentive.com/blog/2013/11/25/the-impact-of-crowdsourcing-on-typhoon-haiyan-response/

[5] http://www.arcticresponsetechnology.org/project-updates/oil-spill-detection-and-mapping-in-low-visibility-and-ice/report-on-oil-spill-detection-and-mapping-in-low-visibility-and-ice-surface-remote-sensing

[6] http://econweb.ucsd.edu/~jsobel/172aw02/notes7.pdf

[7] http://www.uscg.mil/seniorleadership/DOCS/CG_Arctic_Strategy.pdf

[8] Li, Zhang, Zhang An, Zhang Yongfang, and Shi Zhifu. "Study on group air to ground attack-defends hierarchical dynamic decision-making." *Journal of Systems Engineering and Electronics* 18, no. 3 (2007): 540-544.

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

[10] Matsumoto, Mitsutaka. "Formulation and applications of hierarchy games." *International Game Theory Review* 3, no. 02n03 (2001): 189-201.

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

[12] Picard, Rick, Todd Graves, and Jane Booker, "Stability modeling and game-theoretic considerations," *Los Alamos National Laboratory Technical Report*, 1999.

[13] Pourhomayoun, Mohammad, and Mark L. Fowler. "An SVD approach for data compression in emitter location systems." In *Signals, Systems and Computers, 2011 Conference Record of the Forty Fifth Asilomar Conference on*, pp. 257-261. IEEE, 2011.

[14] Rahmes, M., Hackett, J., Fox, K., Pemble, R., Lemieux, G., Gans, H.," A Cognitive Group Hierarchy Game Theoretic Framework for Bandwidth Management" IEEE CogSIMA 2014 Conference, March 2014.

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

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

[17] Slantchev, B., "Game Theory: Static and dynamic games of incomplete information," Dept of Political Science, Univ San Diego, May 15, 2008.

[18] Triantaphyllou, Evangelos, and Stuart H. Mann. "Using the analytic hierarchy process for decision making in engineering applications: some challenges." *International Journal of Industrial Engineering: Applications and Practice* 2.1 (1995): 35-44.

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

[20] Wittman, D., "Arms control verification and other games involving imperfect detection." *The American Political Science Review* (1989): 923-945.

[21] Wunder, Michael, Michael L. Littman, Michael Kaisers, and John Robert Yaros. "A Cognitive Hierarchy Model Applied to the Lemonade Game." In *Interactive Decision Theory and Game Theory*. 2010.

[22] Yao, Xin, and Paul J. Darwen. "An experimental study of N-person iterated prisoner's dilemma games." In *Progress in Evolutionary Computation*, pp. 90-108. Springer Berlin Heidelberg, 1995.

Inter-disciplinary Inquiry-Based Science Experiences for the 21st Century

Dr. Suzanne Lunsford, Ph.D.
Professor of Chemistry
Department of Chemistry
Wright State University
Dayton, OH 45435, USA
Suzanne.Lunsford@wright.edu

Phuong Khanh Quoc Nguyen
Environmental Science Ph.D. Candidate
Wright State University
Dayton, OH 45435, USA
Nguyen.53@wright.edu

Corrie Spradlin
Department of Chemistry
Wright State University
Dayton, OH 45435, USA
Spradlin.17@wright.edu

ABSTRACT
Inter-disciplinary Inquiry-Based Science Experiences that have Science Technology Engineering and Mathematics (STEM) in the undergraduate learning experiences are the learning experiences needed for the 21st century. The laboratory research experiences for my undergraduate science education students working on development of sensors to analysis of field samples changes a typical traditional classroom into a highly interactive learning environment. The inquiry-based labs are required to engage students into problem solving with the process of critical thinking skills. These problem-based skills enable students to generate, evaluate and share their research findings for their sensors developed. The students are required to design the sensor to analyze a sample collected on a field trip. The sensor(s) developed to the samples collected on a field trip are analyzed by technology such as cyclic voltammetry (CV), differential pulse voltammetry (DPV), square-wave anodic stripping voltammetry (SWASV), Scanning Electron Microscopy (SEM), Fourier Transform Infrared Spectroscopy (FTIR), X-Ray Fluorescence (XRF) and Raman Spectroscopy [1-3]. The results of the SWASV will be shared to show the students success at learning how to utilize and develop novel sensors in this talk related to heavy metal detection in water sampling.

INTRODUCTION:
The traditional laboratory experiments are often isolated and ineffective use of learning time and students can fail to understand the content and relevance of the lab. Also, traditional labs do not allow the integration of different disciplines and various instrumentations into one experiment. The old and typical technique for teaching undergraduate chemistry lab is to have a pre-lab lecture followed by a lab to validate the pre-lab lecture given with limited technology

and instrumentation skills developed. This can be referred to as the cookbook technique for teaching undergraduate students chemistry. Guided inquiry-based methods of teaching are useful and allow students to explore the lab problem and proceed to problem solve the lab with guidance by the teacher. Bodner et al., have suggested that guided inquiry-based learning has allowed students to learn better and be more interested in their chemistry studies. [4] The successes of guided inquiry-based experiences have brought about the inter-disciplinary chemistry lab experiences for our undergraduates at our university. These guided inquiry experiences will engage students into the needed technology of studying and understanding various type of instrumentation utilized from not only chemistry but also the field of environmental science/geology, biology, mathematics and engineering aspects.

GUIDED INQUIRY EXPERIMENT EXAMPLE; DISCUSSION/RESULTS:

One of the latest experiments developed was a guided inquiry-based experiment in the detection of heavy metal detection will be discussed in detail. Detection of heavy metals in the low parts per billion (ppb) concentration levels will be displayed. The most recent news from journals published by the *American Chemical Society* are discussing the need for a novel sensor that can detect low detection limits (ppb) range for heavy metals due to the humanitarian disasters in areas such as China, Bangladesh and Vietnam. Typical detection of heavy metals in water samples are utilizing methods such as chromatography, spectroscopic methods and Inductively Coupled Plasma Mass Spectrometry (ICPMS). However, due to the serious problems with heavy metal poisoning to human life there is the need for on-site sampling, in the field sensors that are portable and easy to utilize unlike the methods such as ICPMS. Therefore, electrochemical sensors are ideal for the detection of the heavy metals since this is an environmental concern and in high concentrations naturally in the soil and water in Asian countries.

The electrochemical technique Square wave anodic stripping voltammetry (SWASV) that is easily portable for real-world analysis and inexpensive as well to detect heavy metals was a guided inquiry based lab recently developed to enhance students' instrumental skills and electrochemistry content. The heavy metals are pre-concentrated on bare electrodes such as gold, silver and carbon electrodes via electrochemical reduction for a specified length of time then the electrochemical stripping from the bare electrodes surface results in the faradaic signal which is used to determine the concentration present. The current due to the heavy metals oxidation is featured as peaks with heights proportional to the concentration of the heavy metal present. The focuses of the lab were determining the optimum electrochemical technique such as cyclic voltammetry or SWASV. Also, the pH level that the optimum value to detect the heavy metals and the SWASV parameters on the bare electrodes such as frequency, amplitude, deposition potential and deposition time were analyzed.

The successes of the students' detection of heavy metal detection at the different bare electrodes by SWASV illustrated such low detection in the ppb range. The pre-and post-tests assessment of the students content

knowledge was an overall gain of n=0.73; which illustrated a high gain according to R.R. Hake method. [5] This lab can be further expanded into more guided inquiry by more in-depth development of the sensor to detect lower than ppb levels of heavy metals in water; down to the ppt levels. This study of the morphological surface of various modified electrodes with polymers to possible sol-gel materials could achieve even lower detection limits (ppt levels) in a real-world analysis sample on site with limited contamination issues of fouling electrode surfaces. Therefore, this lab can be further continued as a guided inquiry experience, which has gained interest of students while engaging their problem solving skills to detect these heavy metals. [6-7] The successes of the electrochemistry experiments in an inquiry-based mode will be shared to show how the 21st learning is vital to meet the needs of todays research endeavors while integrating electrochemistry with technology such as CV and SWASV (BASi-instrumentation).

Acknowledgement: Thanks to Phuong Quoc Nguyen and Corrie Spradlin for their assistance with the lab development at Wright State University. Thanks for Dr. Ted Clark and OSU for contributions to Research Experiences for Undergraduate Learning Experiences as well. Dr. Roger Gilpin from Wright State University for the helpful suggestion to create more labs related to heavy metals detection by electrochemistry techniques.

Keywords: Hands-on/Inquiry-based learning, Professional Development, Inter-disciplinary Science, and Informing via Research.

REFERENCES:

1. M. Hughes, B. Muir, A. Schulte, and S. Lunsford, *The Chemical Educator*, **18**, 152-154 (2013).

2. M. Hughes, B. Muir, and S. Lunsford, *The Chemical Educator*, **18**, 123-125 (2013).

3. Lunsford, S., Hughes, M., and Nguyen, P., *Systemics, Cybernetics, and Informatics, Vol. 11, Number 6, 32-35 (2013).*

4. G.M. Bodner, W.J.F. Hunter, R.S. Lamba, *The Chemical Educator*, **3,** *1-21(1998).*

5. R.R. Hake, *Am. J. Phys.*,**66** (1), 64-74 (1998).

6. Simm, A., Banks, C., and Compton, R., Electroanalysis, ***17***, 1727 (2005).

7. Fosberg, G., O'Laughlin, J.W., Megargle, R.G., *Anal. Chem*., ***47***,1586 (1975).

Fostering Interdisciplinary Collaboration to Improve Student Learning

Ronald A. Styron, Jr., Ed.D.
Quality Enhancement Plan Director and Professor of Educational Leadership
Office of Academic Affairs, University of South Alabama
Mobile, AL 36688, United States of America

Jennifer L. Styron, Ph.D.
Assistant Professor
Community Mental Health
College of Nursing, University of South Alabama
Mobile, AL 36688, United States of America

ABSTRACT

The purpose of this study was to compare the impact on student learning of those enrolled in courses where instructors participated in collegial coaching and peer mentoring. A nonequivalent group design methodology was employed along with an analysis of variance to analyze data. Findings indicated higher mastery levels of student learning outcomes, higher levels of perceived critical thinking and collaboration by students, statistical significance in critical thinking constructs, higher levels of persistence, and more A's and B's and fewer D's and F's in courses where faculty members were mentored as compared to courses where faculty members were not.

Keywords: Interdisciplinary Collaboration, Student Learning, Collegial Coaching, Mentoring

INTRODUCTION

Several professors involved in the university Quality Enhancement Plan decided the best way to ensure successful implementation of Team-Based Learning [1], a common instructional strategy used across multiple disciplines, was to support each other through collegial coaching. They had face-to-face meetings each week to discuss lessons learned, shared resources, and communicated via email and blogs. They also sought out support from the project director when needed. Their efforts were the impetus for mentoring along with coaching that would result in improved collaboration and student learning.

The subsequent mentoring and coaching promoted exploration, critique, and reflection to transform practice [2]. There was no preaching; only thoughtful, reflective questions aimed at guiding colleagues to the answers they sought. Collegial coaching created an environment of openness for peer mentoring. Professors provided each other advice, support, and encouragement by leading and guiding by example. They engaged in collaborative practices to enhance teaching and learning relative to the implementation of Team-Based Learning. They also frequently attended professional development activities with follow-up discussion [3].

Coaching and peer mentoring facilitated effective professional development and helped break down the cycle of instructor isolation. It also served as a communicative structure that allowed the flow of information to instructors regarding the Team-Based Learning techniques that were working [4]. Coaching sessions were productive conversations between faculty concerning student learning. They also served as acknowledgement of small wins as new innovations were being implemented [5]. Sessions fostered collegial teams that stimulated content innovation.

The collegial coaching method utilized for this project was based on a collaborative mentoring strategy called Learning Walks. Learning Walks are a professional development process designed to support thinking about instructional practice. They are designed to raise questions and promote self-reflection. The process leads to an instructional community concentrated on the examination of practice with no hidden agendas [6]. The project director introduced Learning Walks and provided training to peer mentor participants.

CONCEPTUAL FRAMEWORK

Learning Walks

Learning Walks [6] are a form of collegial coaching that provide a structure for interprofessional collaboration and were designed to help establish a common understanding of practice about the delivery of Team-Based Learning. Learning Walks help to open classroom doors and provide a collaborative professional culture offering a method for professional reflection. The focus of Learning Walks is on questioning strategies, classroom ecology (student-student & student-instructor interactions) and active student engagement.

A team consisting of 2 to 3 novice instructors, plus a veteran instructor, conducted classroom visitations twice a semester. Reflective questioning was used as a way to initiate dialogue about teaching and learning, as a way to look back at what happened and what was learned, and a way to look forward and resolve challenges that may arise. The classroom visitation phase of Learning Walks consists of four steps [6]:

1. Preparation. Including: a) Assembly of members of the Learning Walk team, b) Discussion of the Team-Based Learning Scorecard [7], c) Discussion of student learning outcomes, and d) Determination of the type of evidence required for mastery of learning outcomes.

2. The classroom visit. Team members: a) enter the classroom at the same time, b) do not speak to each other during the classroom visit, c) remain unobtrusive, but may speak with student or look at their work, and d) observe student-student and student-teacher engagement.
3. Team debriefing. Team members ask: Were students engaged in meaningful learning? b) Were higher order thinking and collaboration addressed? c) Were student-learning outcome(s) addressed?, and d) Was there something you observed that you would use in your classroom?
4. Closing Conversation between mentor and instructor. Mentor asks: Did it go as planned? b) Would you do anything differently? and c) What was observed. The conversation concludes with a discussion of ideas, strategies, and/or techniques that can be used in future classes.

Peer Mentoring

The growth of any craft depends on shared practice and honest dialogue among the people who do it. We grow by trial and error, to be sure—but our willingness to try, and fail, as individuals is severely limited when we are not supported by a community that encourages such risks [8, p. 144]. Engaged professionals who collaborate in learning teams hold themselves to a higher standard, improve their practice, and lift student achievement [9]. Instructors were divided into teams representing several disciplines across campus. They also received Learning Walk training.

Peer mentoring was defined as collaboration between experienced person who provides information, advice, support, and encouragement to a less experienced colleague by leading and guiding by example. Mentors engaged in an active, collaborative, year-long program aimed at enhancing teaching and learning through regular coaching, mentoring, and professional development activities. Mentors asked thoughtful, reflective questions that helped guide colleagues to the answers they sought. The purpose of mentoring was to provide a supportive environment for members of the improvement plan, facilitate collegial coaching, stimulate scholarly dialogue, provide assistance and opportunities for professional growth, provide opportunities for practice and guidance pertaining to the acquisition of Team-Based Learning strategies in a non-evaluative environment, and to develop learning communities constructed around professional improvement.

Mentors invited member of their cohort into their classroom for observation and coaching, organized and facilitated discussion sessions, and coordinated Learning Walks as relative to the implementation of Team-Based Learning. They were asked to be good listeners, avoid situations with other members of the cadre that they were not qualified to deal with or direct them to someone who could, be approachable, available, follow up on commitments, be realistic and encouraging, maintain confidentiality, and maintain accountability throughout the mentoring process. Most importantly, mentors were asked to coach and not judge [10].

Mentoring required a substantial time commitment to attend training and to facilitate Learning Walks. As a gesture of appreciation, mentors were allocated up to $1,000 for presentations at peer-reviewed professional conferences. Mentors also received training and support from the project director. Furthermore, those involved as mentors received a special Certificate of Collegial Coaching and Mentoring.

Team-Based Learning as a Common Pedagogy

Team-Based Learning [1] is a special form of collaborative learning using a specific sequence of individual work, group work and immediate feedback to create a motivational framework in which students increasingly hold each other accountable for coming to class prepared and contributing to discussion. Team-Based Learning was the common instructional strategy utilized by those who participated in the Quality Enhancement Plan. It was selected prior to the initiation of the plan by an advisory committee based on a review of student assessment data.

Deutschlander**,** Suter and Lait [11] developed a model for interprofessional education called the *IP Enhancement Approach.* This approach was developed to improve program reach, implementation and sustainability. It included the use of existing class schedules along with common content, pedagogies or instructional techniques. One could consider the use of Team-Based Learning as an IP Enhancement since it was used as a common pedagogy linking multiple disciplines to boost problem-solving, decision making and higher order thinking required for interdisciplinary endeavors.

Team-Based Learning Scorecard. Michaelsen and Sibley [7] developed a scorecard to help ensure fidelity of Team-Based Learning implementation. This scorecard was used as a collective starting point to stimulate conversation leading to observation of classes and subsequent discussion. The scorecard addressed focus, team formation (selection, composition and process), orientation of students (rationales and grade weights), readiness assurance process (frequency, focus of questions, feedback, appeals and link to activities), application activities and assignments (problem significance/relevance, problem selection, deliverables and reporting), individual accountability (accountability to instructor and peers), and team accountability (impact of team assignments and feedback on team assignments).

METHODOLOGY

This was a descriptive quantitative study framed by a modified action-research cyclical framework beginning with data collection, initiation based on the data, evaluation of outcomes, revisions; and finally a continuous planning, acting, and evaluating cycle. The study explored differences between variables in mentored and non-mentored courses. Student assessments utilized in this study included the Student Learning Target Mastery Report, Critical Thinking and Collaboration Pre- and Post-Tests, and the California Critical Thinking Skills Test (CCTST). Withdrawal and grade distribution data were also gathered from the university data management system and utilized for analysis. Additionally, the faculty feedback survey contained three questions pertaining to mentoring and collaboration.

Research Questions

This study examined student achievement in courses where faculty were mentored as compared to courses where faculty were not mentored. The research questions guiding the study included:

RQ 1: Will faculty members perceive mentoring as having a positive impact on relationships, communication and collaboration with their colleagues?

RQ 2: Will there be a difference in mastery of student learning outcomes in courses where faculty members were mentored/coached as compared to student learning outcome mastery in courses where faculty members were not mentored/coached?

RQ 3: Will there be a difference in perceived levels of critical thinking and collaboration among students enrolled in courses where faculty members were mentored/coaches as compared to courses where faculty members were not mentored/coached?

RQ 4: Will there be a difference in critical thinking constructs in courses where faculty members were mentored/coaches as compared to courses where faculty members were not mentored/coached?

RQ 5: Will there be a difference in student persistence in courses where faculty members were mentored/coached as compared to courses where faculty members were not mentored/coaches?

RQ 6: Will there be a difference in student grades in courses where faculty members were mentored/coached as compared to courses where faculty members were not mentored/coached?

Participants

Mentoring participants consisted of 17 self-selected instructors from the colleges of Allied Health, Arts and Sciences, and Continuing Education. Four mentoring participants (23.5%) were male and 13 (76.5%) were female. Mentoring participants served 543 students in 22 undergraduate and graduate classes. Non-Mentoring participants consisted of 33 instructors from the colleges of Allied Health, Arts and Sciences, Business, Continuing Education, Education, Engineering, Medicine, Nursing and the School of Computing. Fifteen (45.4%) non-mentoring participants were male and 18 (54.6%) were female. These instructors served 970 students in 46 undergraduate and graduate classes.

Assessments

Student Learning Outcome Target Mastery Report. The Student Learning Outcome Target Mastery Report consisted of 3-6 student-learning outcomes that were matched with assessments and a target mastery level, or benchmark, established by the instructor. These outcomes were connected with one of the four following domains: analyzing, applying, creating, or evaluating. The report was developed by instructors and submitted to the project director for feedback at the beginning of the semester. At the end of the semester, instructors reported the target mastery levels for each domain that were met and those that were not. A brief narrative was provided for all benchmarks that were not met including a rationale and improvement strategy. Student learning outcomes found in the Target Mastery Report were based on higher order thinking aligned with Bloom's Taxonomy of Revised Cognitive Domains [12].

Critical Thinking and Collaboration Pre- and Post Tests. The Critical Thinking and Collaboration Pre- and Post-Tests consisted of 20 likert scale survey questions. Likert questions used the following rating scale: 5=Strongly Agree, 4=Agree, 3=Neutral, 2=Disagree, 1=Strongly Disagree. Nine questions pertained to critical thinking and 11 pertained to collaboration. For both critical thinking and collaboration, the respective items were summed and then divided by the total number of scores to get a mean score in each domain. Students enrolled in participant courses were sent the survey at the beginning and again at the end of the semester using a web-based software system called Class Climate.

California Critical Thinking Skills Test. The California Critical Thinking Skills Test, created by Insight Assessment [13], is a standardized test normed with other four-year universities located in the United States. It was administered at the end of the semester. The California Critical Thinking Skills Test provides return scores on the following scales: analysis, evaluation, inference, deduction, induction, interpretation, evaluation, and overall reasoning skills.

Persistence and Grade Reports. Persistence was determined through the calculation of course withdrawals of students enrolled in the mentoring participants' courses and non-mentoring participants' courses. Course grades were obtained and utilized to compare grades from the mentoring participants' courses and non-mentoring participants' courses.

Faculty Feedback Survey. The Faculty Feedback Survey consisted of 4 sections, 1) Project Overview, 2) Instructor Recognition and Professional Development, 3) Implementation of Team-Based Learning, and 4) Project Improvement. Each section of the survey contained both Likert and open-ended questions. Likert questions used the following rating scale: 5=Strongly Agree, 4=Agree, 3=Neutral, 2=Disagree, 1=Strongly Disagree. Items cited in the findings of this study were contained in the Project Overview section.

Data Analysis

Descriptive statistics were reported for items in the Faculty Satisfaction Surveys, Student Learning Outcome Target Mastery Report, the Critical Thinking and Collaboration Pre- and Post-Tests, and the California Critical Thinking Skills Test. Other various analyses including Pearson chi-square tests, one-way analysis of variance (ANOVA) tests, and a one-way multivariate analysis of variance (MANOVA) were conducted. Appropriate tests were selected for each research question to determine statistical significance of items found in these assessments.

FINDINGS

Faculty Perceptions of Mentoring

As seen in Figure 1, there were three questions pertaining to the mentoring experience included on the faculty satisfaction survey administered at the end of the academic year. Mean scores indicate positive perceptions of mentoring/coaching for all three items with scores approaching o exceeding a score of 4.0.

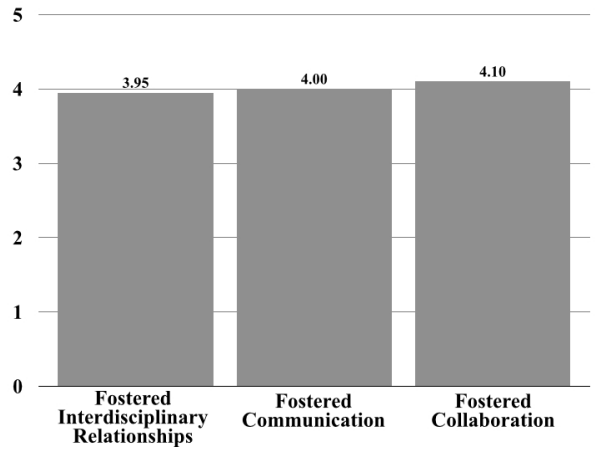


Figure 1. Faculty Satisfaction Survey Results, $N = 17$. The minimum score was 1.0 and the maximum score was 5.0 on all three items.

Mastery of Student Learning Outcomes by Faculty Group

To complete the Student Learning Outcome Target Mastery Report, instructors developed student-learning outcomes addressing higher order thinking skills, linked each one with appropriate assessments and then determined whether mastery levels were met. Data were disaggregated by Cognitive Domains (analyzing, applying, creating, and evaluating) relative to higher order thinking found in Bloom's Revised Taxonomy [12]. Comparisons of categorical variables were made using Pearson chi-square tests. As seen in Table 1, the percentages of mastery levels met were significantly different for each domain. Mentoring/coaching participants' courses reporting higher levels of mastery level percentages met were: analyzing, χ^2 (1, N = 681) = 91.52, $p < .01$; applying, χ^2 (1, N = 454) = 63.80, $p < .01$; creating, χ^2 (1, N = 500) = 19.31, $p < .01$; and overall mastery, χ^2 (1, N = 500) = 62.60, $p < .01$. In the evaluating domain percentages were also significantly different. However, percentages of mastery levels met were higher for non-mentoring/coaching participants' courses, χ^2 (1, N = 468) = 102.12, $p < .01$.

Table 1

Student Learning Outcome Target Mastery Percentages

	Group 1	Group 2
Cognitive Domain	% Met	% Met
Analyzing	84.4	47.6
Applying	97.0	70.5
Creating	95.2	82.6
Evaluating	19.7	70.7
All Domains	81.0	65.3

Note. All percentages significant at the .01 level. Group 1 = Mentored/Coached, Group 2 = Non-Mentored/Coached

Critical Thinking and Collaboration Scores by Faculty Group

Students in courses with mentored/coached and non-mentored/coached faculty completed a critical thinking and collaboration pre- and post- test. Because pre- and post-test scores could not be matched, these scores were treated independently. A one-way analysis of variance (ANOVA) was conducted to determine differences between mentored and non-mentored group scores, differences in pre-and post-test scores, and the interaction of these two variables for both critical thinking and collaboration. Each will be discussed below.

Critical Thinking. Results of the one-way ANOVA indicated no difference in critical thinking scores based on group, F (1, 3) = .51, p = .30. A statistically significant difference in pre- and post-test critical thinking scores was found regardless of group, F (1, 3) = 5.32, p = .01. Additionally, a significant interaction was found between mentored/coached and non-mentored/coached group and pre- and post- tests, F (1, 3) = 5.36, p = .01. As evidenced in mean score data presented in Table 2, the mentored/coached group's critical thinking post-test scores showed significant improvement as opposed to the non-mentored/coached group.

Table 2

Critical Thinking Pre- and Post-Test Mean Scores

Group	Test	Mean	Std. Deviation
1	Pre	3.57	.65
	Post	3.83	.70
2	Pre	3.74	.66
	Post	3.74	.74

Note. The minimum score was 1.0 and the maximum score was 5.0 on both the pre-and post-test. Group 1 = Mentored/ Coached, Group 2 = Non-Mentored/Coached

Collaboration. Results indicated no difference in collaboration scores by group, F (1, 3) = .22, p = .64. However, pre- and post-test collaboration scores were significantly different regardless of group, F (1, 3) = 19.03, p = .01. Additionally, there was a statistically significant interaction between mentored/coached and non-mentored/coached groups and pre- and post- tests with the mentored/coached group having significantly higher levels of improvement in pre- and post- test collaboration scores over the non-mentored/coached group, F (1, 3) = 3.50, p = .02. As seen in Table 2, while both mentored/coached and non-mentored/coached groups showed improvement in mean scores on post-tests, mean collaboration scores for the mentored/coached group were much better than those of the non-mentored/coached group.

Table 3

Collaboration Pre- and Post- Test Mean Scores

Group	Test	Mean	Std. Deviation
1	Pre	3.26	.69
	Post	3.55	.68
2	Pre	3.35	.80
	Post	3.43	.84

Note. The minimum score was 1.0 and the maximum score was 5.0 on both the pre-and post-test. Group 1 = Mentored/ Coached, Group 2 = Non-Mentored/Coached

Critical Thinking Constructs by Faculty Group

The California Critical Thinking Skills Test (CCTST) was administered at the end of the semester to measure the critical thinking skill level of each student. The CCTST measures test-taker's reasoning skills on the following scales: induction, deduction, analysis, inference, evaluation, interpretation, explanation, and overall reasoning skills. Students in both the mentored/coached faculty courses as well as the non-mentoring/coached faculty courses were asked to take the CCTST. A one-way multivariate analysis of variance (MANOVA) was conducted to determine whether a difference existed in critical thinking scales in courses where faculty members were mentored/coached as compared to courses where faculty members were not mentored/coached. Results indicated a statistically significant difference in CCTST scales based on group course placement (mentored/coached or non-mentored/coached), Pillai's Trace = .258, F (7, 45) = 2.24, p = .05. The univariate F tests showed there was a statistical difference between mentored/coached and non-mentored/coached group scores for deduction, F = 12.25, df = (1), p = .01; analysis, F = 5.91, df = (1), p = .02, and inference, F = 12.87, df = (1), p = .01. Table 4 provides means and standard deviations for each of the CCTST scales.

Table 4

CCTST Scale Mean Scores

Subscale	Group	*N*	Mean	*SD*
Induction	1	19	75.92	8.79
	2	34	73.39	6.93
Deduction	1	19	74.82*	6.43
	2	34	68.72*	5.88
Analysis	1	19	74.74*	6.12
	2	34	70.44	6.20
Inference	1	19	77.01	4.13
	2	34	71.26	6.25
Evaluation	1	19	71.73	9.94
	2	34	68.29	7.23
Interpretation	1	19	77.76	10.68
	2	34	74.19	7.92
Explanation	1	19	72.63	12.56
	2	34	68.65	8.83

Note. All scores are on a 100-point scale. * indicates significance at $p < .05$. Group 1= Mentored/Coached, Group 2 = Non-Mentored/Coached

Additionally, reports provided from Insight Assessment [13] compared group (mentored/coached or non-mentored/coached) scores to an aggregate sample of CCTST Four Year College Students. The assessment indicated that student scores within the mentored/coached faculty group were in the 37th percentile while student scores within non-mentored/coached faculty group were in the 20th percentile.

Student Persistence by Faculty Group

Student withdrawal rates were calculated for all courses in the study. A Pearson chi-square test was conducted to determine if course withdrawal rates were significantly different based on faculty group (mentored/coached or non-mentored/coached). Results of this analysis show no difference of withdrawal rates by group, χ^2 (1, N = 1511) = .89, $p < .35$. Although no significant difference was found, there was a slight decrease in course withdrawals with 2.3% (N = 13) in mentored courses and 3.1% (N = 29) in non-mentored courses.

Student Grades by Faculty Group

Student course grades were obtained and utilized to determine whether course grades differed by faculty group (mentored/coached or non-mentored/coached). A Pearson chi-square test was conducted and indicated no difference of course grades by group, χ^2 (4, N = 1489) = 2.21, $p < .70$. While only one faculty group received mentoring, both groups were trained on Team-Based Learning, which is an evidence-based instructional strategy. The lack of statistical significance may be a result of training and recurring professional development geared toward improving instruction.

CONCLUSIONS

In this study, student critical thinking and collaboration competencies, student persistence, student grades and faculty perceptions were compared between two groups of faculty members participating in a university-wide improvement plan called a Quality Enhancement Plan (QEP). One group, consisting of 17 faculty members, participated in peer mentoring and coaching using a collegial coaching strategy called Learning Walks. The other group, consisting of 33 faulty members, participated in the QEP but received limited mentoring only by the project director.

Learning Walks were the focal point of the mentoring/coaching strategy. The strategy helped faculty members develop collegial relationships through structured classroom visitation and conversation centered on the pedagogical use of Team-Based Learning. Mentors served as facilitators of 2 to 3 faculty instructors who remained together in the same group all year. They engaged in reflective questioning with members of the group, and helped them develop and internalize instructional improvement personalized to their individual needs. Learning Walks, along with similar strategies called walkabouts, instructional walks, and focused walks, are not commonly used in university settings and represent a new way to foster professional dialogue and learning communities meant to enhance classroom instruction and student learning.

Although statistical significance was not found throughout all of the assessment data, overall, findings indicated higher assessment scores in courses where faculty participated in peer mentoring and coaching. The lack of significance may be a result of the informal mentoring that took place between instructors and the project director, and between each other during numerous professional development activities held throughout the year. Fidelity of implementation may have also been a factor as there was no system of checks and

balances to ensure compliance with the Learning Walk model. Additionally, course grades may have improved in both groups because they utilized the same instructional strategy, Team-Based Learning, which has been shown to improve grades in several studies [14, 15, 16].

Faculty indicated that mentoring improved interdisciplinary relationships, and fostered interdisciplinary communication and collaboration. These findings are consistent with similar research that found faculty peer mentoring beneficial [17, 18, 19]. Utilization of Learning Walks at the university level represents a promising method for instructional improvement. As a result, this method of mentoring and coaching should be furthered explored through additional research.

Moreover, Team-Based Learning, because of the use of application activities as culminating instructional events, may be employed as a common instructional strategy across multiple disciplines to enhance interprofessionalism and interdisciplinarity. Team-Based Learning application activities are designed around instructional techniques using case studies or scenarios with embedded problems and decision points to facilitate enriched discussion, collaboration and higher order thinking. The comprehensive nature of this types of application activity implies the integration of content from multiple disciplines.

RECOMMENDATIONS FOR FUTURE RESEARCH

It is recommended that this study be replicated in other university settings to help assess the effectiveness of the peer mentoring/coaching model used in this study. It is also recommended that the study go beyond instructors participating in university improvement plans and include those in the other general faculty populations.

REFERENCES

[1] Michaelsen, L. K., Knight, A. B., & Fink, L. D. (2004). *Team-Based Learning: A transformative use of small groups in college teaching.* Sterling, VA: Stylus.

[2] Sherris, A. (2007). The lay of the land. In A. Sherris, T. A. Bauder, & L. Hillyard, *An insider's guide to SIOP coaching* (pp. 3–13). Washington, DC: Center for Applied Linguistics.

[3] Bachkirova, T. & Cox, E. (2004). 'A bridge over troubled water: Bring together coaching and counseling', *International Journal of Mentoring and Coaching, 2*(1), pp. 2-9.

[4] Waters, T., Marzano, R. J., & McNulty, B. (2003). *Balanced leadership*. Retrieved from http://www.mcrel.org/PDF?LeadershipOrganizationDevelopment/5031RR_BalancedLeaadership.pdf

[5] Schmoker, M. (1999). Results: The key to continuous school improvement. Alexandria, VA: Association for Supervision and Curriculum Development.

[6] Guilott, M. C., & Parker, G. A. (2012). *A value added decision: To support delivery of high level instruction.* Outskirt Press, Parker:CO.

[7] Michaelsen, L. K., & Sibley, J. (2009). *Team Based Learning Scorecard*. Retrieved from http://www.teambasedlearning.org/Resources/Documents/course_scorecard.pdf

[8] Palmer, P. (1998). *The courage to teach*. San Francisco: Jossey-Bass.

[9] Rich, E. (2010). Teaching commission pushes collaborative learning teams, *Education Week.Org,* June 29, 2010.

[10] Caldwell, B.J. & Carter, E.M.A. (1993). *The return of the mentor: strategies for workplace learning*. London: The Falmer Press.

[11] Deutschlander, S., Suter, E., & Lait, J. (2011). Models in interprofessional education: The IP enhancement approach as effective alternative. *Work 41*(3), 253-260.

[12] Anderson, L. W. & Krathwohl, D. R., et al (Eds..). (2001). *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. Allyn & Bacon. Boston, MA: Pearson Education Group.

[13] Insight Assessment. *California Critical Thinking Test. Retrieved from http://www.insightassessment.com/Products/Products-Summary/Critical-Thinking-Skills-Tests/California-Critical-Thinking-Skills-Test-CCTST*

[14] NEA (2010). *Try This – Team-Based Learning.* Adapted from an article in NEA's Higher Education Advocate (June 2008, www.nea.org/home/34362.htm) by Larry Michaelsen, University of Central Missouri and Michael Sweet, University of Texas at Austin. Retrieved from http://www.nea.org/home/37229.htm

[15] Ofstad, W., & Brunner, L. J. (2013). Team-Based Learning in Pharmacy Education. *American Journal fo Pharmaceutical Education, 77*(4), 66-87

[16] Brame, C. J. (n.d.) *Team-Based Learning. What is it?* Vanderbilt Center for Teaching. Retrieved from http://cft.vanderbilt.edu/guides-sub-pages/team-based-learning/

[17] National Institute for Staff Development (2012). *Innovation Abstracts, 34*(8). Retrieved from http://www.pstcc.edu/qep/_files/pdf/XXXIV_8.pdf

[18] Driscoll, L. G., Parkes, K. A., Tilley-Lubbs, G. A, Brill, J. M., & Pitts Bannister, V. R. (2009). Navigating the lonely sea: Peer mentoring and collaboration among aspiring women scholars. *Mentoring & Tutoring: Partnership in Learningm 17*(1), 5-21.

[19] Heinrich, K. T., & Oberleitner, M. G. (2012). How a faculty group's peer mentoring of each other's scholarship can enhance retention and recruitment. *Journal of Professional Nursing, 28*(1), 5-12.

A Discipline-Independent Approach to a Higher Cognitive Pedagogy

Russell Jay Hendel
Department of Mathematics, 8000 York Road
Towson Maryland, 21252
RHendel@Towson.Edu

ABSTRACT

We present a content-independent formulation of *higher cognitive pedagogy*, by identifying higher cognitive pedagogy with executive function which in turn we equate with continual multi-dimensional processing of drivers of outcomes. The key focus in this definition is on *multiple* dimensions. We apply our definition to four diverse disciplines: a) mathematical modeling of verbal problems is presented as an interaction between the dimensions of language and algebra; b) complex mathematical problems are presented as an interaction between multiple sub-problems participating in one solution; c) essay writing is presented as an interaction between specific atomic competency skills – creating meaningful sentence pairs – and hierarchical organization into greater wholes such as paragraphs and essays; d) foreign language translation is presented as a dimensional parsing of hypernyms and hyponyms; similarly, literary translation is presented as a dynamic interaction between multiple dimensions of a literary work. We show consistency and correlation between the executive-function pedagogical approach and the Bloom-Anderson approach.

Keywords: cybernetics, executive function, multi-dimensional processing, modeling, complex mathematical problems, organizational writing, Bloom-Anderson, hypernyms,hyponyms

1. OVERVIEW

Many independent sources have called for a reform of modern education with an emphasis on *higher order thinking skills.* Consequently, implementation of reform requires a precise definition of *higher order thinking skills.*

1.1 The Traditional Approach

The traditional approach of defining higher order thinking skills is to present hierarchies of learning attributes. This approach was initiated with the Bloom taxonomy [4]: – *knowledge, comprehension, application, analysis, synthesis and evaluation*. This taxonomy is typically applied as follows: If one is teaching a discipline, one evaluates each module and learning unit by ascertaining if the primary focus is exclusively on knowledge and comprehension versus whether applications of the learning unit are presented which require analysis, synthesis and evaluation on the part of the instructor and student.

Several other pedagogists, for example, Anderson [2], Webb [29-31], Marzano [20], present competing or complementary hierarchies. Some pedagogists – for example, Gagne [10], and Van Hiele [28] – characterize their hierarchies as representing stages of learning.

A recent development in this use of hierarchies is the demonstration of a correspondence and consistency between superficially different hierarchies. Thus Yazdani [33] showed the approaches of Gagne and Van Hiele equally effective in teaching geometry; Hess [13,14] studied the interaction of Bloom-Anderson and Webb by creating a matrix and classifying several thousand mathematics and English homework assignments in K-12 by their Webb and Bloom levels.

1.2 This Paper's Approach

In Section 2, we approach the problem of defining higher order thinking skills by appealing to brain function. More specifically, we identify higher order thinking skills with activities requiring executive brain function. While executive function itself is an elusive concept, there being several aspects to executive function [22,26], it is generally agreed that executive function is a higher order brain function. Executive function refers to the capacity of the brain to deal with complex tasks. By explicitly relating higher order thinking skills to brain function we take one step towards objectifying and concretizing the definition.

We provide further concretization by identifying commonality in several executive-function performance tests. Several tests of executive function assess continual multi-dimensional processing of environmental information to accurately determine drivers of outcomes. This, the multi-dimensional processing of information to determine drivers, becomes our working definition of higher order thinking skills.

Such an approach is objective, operational and mechanistic. It enables an instructor to instantly evaluate learning material for the presence of higher order thinking skills.

1.3 Atomic Skill Competencies

We have identified higher order thinking skills with multi-dimensional processing. We further suggest identifying the atomic skill competencies of each educational domain as the multiple dimensions interplaying in determining outcomes. In Section 2.2 we rigorously define atomic skill competency.

1.4 Cybernetic Approach

Throughout our discussion, analysis is exclusively dependent on information flow and independent of content. The analysis of a complex domain in terms of information flow independent of content is the distinguishing attribute of cybernetics [8].

We are particularly indebted to the cybernetician Ashby [9] who focused on eliminating terms such as *higher order* from psychology and replacing them with more mechanistic and operational concepts. In so doing, Ashby was not trying to remove complexity from psychology but on the contrary, trying to preserve it in a more respectable manner.

1.5 Outline

Section 2 presents the definitions of executive function and atomic skill competency. Sections 3-6 apply our definitions to the domains of verbal-problem modeling, English writing, mathematics, literary criticism and foreign language translation. The application of our definition to such diverse disciplines supports the content-independent nature of our approach.

2. EXECUTIVE FUNCTION AND ATOMIC SKILLS

This section reviews executive-function performance tests, clarifies the meaning of multi-dimensional processing, rigorously defines skill competency, and uses these two concepts - skill and multi-dimensional processing - to define our approach to pedagogy which we show consistent with Bloom-Anderson.

2.1 Executive Function Performance Tests

As already indicated in Section 1, executive function refers to multiple brain fucntions. There are multiple executive function tests the two main categories being performance and rating tests [26]. We examine three well known performance tests.

The Wisconsin Card Sorting Test (WCST) [12]: During the administration of the WCST, the examiner flashes several dozen two-row items such as those found in Figure 1. The examinee is asked to match the card in the bottom row with the appropriate card in the top row. An illustrative example is presented in Figure 1.

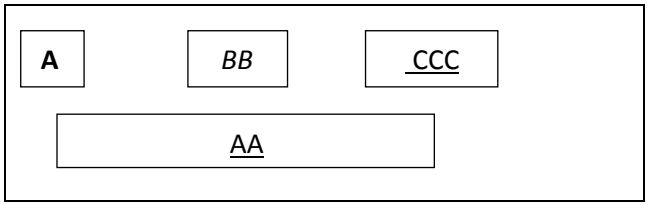


Figure 1: A sample item in the WCST. Throughout this section performance tests have been modified, from their standard format, for typographical reasons and reasons of space.

Abstractly, Figure 1 presents three dimensions: a) letter (A,B,C), b) formatting (bold, italic, underline), and c) number (1,2,3). The examinee must determine if the two A's in the bottom row of Figure 1 resemble the A card because of the dimension of letter, resembles the B card because of the dimension of number or resembles the C card because of the dimension of formatting (both are underlined).

Typically, after a few attempts the examinee will discover the correct driver of resemblance. The examinee will then have a streak of correct answers. The examiner may then change the driving dimension. For example, if in the last 10 trials the correct answer was based on a match of number, the examinee may create new trials where the correct match is based on the dimension of letter resemblance.

A wealth of information is gathered during the test. For our purposes, we see that the examinee is being tested on *his/her capacity to correctly identify the driving dimension from a set of competing multiple dimensions (formatting, number, letter). Furthermore, as time progresses the examinee must continuously reassess the correct driver of correctness.*

We conclude that the WCST is measuring the capacity of the examinee to *continuously process multiple-dimensional drivers of outcome.* We argue that this is the essence of higher order thinking skills.

The Trailmaking test [6,7,11]: This deceptive but beautiful test has two parts: A and B. In both parts, the examinee is asked to make a trail: In part A, the trail is 1-2-3-…, while in part B, the trail is 1-A-2-B-3-C…. An illustrative example is presented in Figure 2. Although these tasks are easy, remarkably, the part B test always takes longer. The increased length is due to the presence of two dimensions: number and letter. The multi-dimensionality requires executive function and hence the increased time length. Despite the test's simplicity, it is useful in diagnosing brain damage and recovery possibility, for example after a stroke.

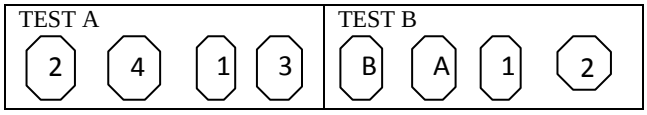


Figure 2: A sample Trailmaking test.

The simplicity of this test highlights the importance of our proposed definition that higher order thinking skills equate with multi-dimensional processing. The trailmaking test is making the powerful point that *any* multi-dimensional processing transforms a mundane exercise into executive-function quality. Indeed, just adding the dimensions of letter to the dimension of number in the simple task of making a trail raises the quality of the task to executive-function quality.

The Stroop Interference Test [16, 25]: In this test, the examinee is presented with two lists of words and asked to identify the color of each word in the list. The first list typically has only one dimension, color, and hence can be done quickly. The second list has two dimensions word meaning and letter color. For example the word "red" may be written in blue font, requiring the examinee to process two dimensions, word meaning and color, to arrive at a correct answer. This multi-dimensionality requires executive function and hence the second test typically requires more time (over several dozen trials), something measurable.

Summary: We identify higher order thinking skills with executive function. Executive-function performance tests measure the capacity to continuously process competing multiple dimensions to ascertain driving forces. We conclude that higher order thinking skills should be identified with multi-dimensional processing capability.

2.2 Atomic Skill Competencies

Although the pedagogic literature uses the word *skill*, it is infrequently (if ever) precisely defined. The psychological literature defines a skill as any task that *under repeated performance a) increases in speed and b) decreases in error rate* [19] For example, reciting the alphabet, plugging into a mathematical formula, developing a topic sentence by giving examples or consequences, are all examples of skills.

Contrastively, writing an essay, doing a complex math problem, writing a complete computer program are all non-skill acts. For example, you cannot speak about the error rate in writing an essay since essays are not right or wrong. Similarly, increased practice does not increase essay writing speed. It is not a skill.

We now explain the word *atomic*. An atomic skill competency is a skill that cannot be decomposed further. For example, writing a paragraph basically consists of applying multiple skills, that is, multiple methods of developing topic sentences. A topic sentence may be developed by *cause*, *consequence*, *example*, *analogy*, *contrast* etc. *Each* particular method of development is an atomic skill competency: You can practice say developing a topic sentence by *consequence* until you can do so quickly and without error. Contrastively, the *entire* paragraph writing, the development of the topic sentence, is a skill composed of multiple atomic skills. Writing a paragraph is a skill competency but not an *atomic* skill competency.

Of utmost importance is that atomic skill competencies need not be classified exclusively as memorization and performance, lower order skills. To fully understand this recall that our definition of higher order thinking skills exclusively requires the presence of executive function. A recent study [15] shows that memorization and performance when combined with executive function is higher order; in fact, multi-dimensional performance surprisingly improves intelligence.

In this study, number-letter pairs were flashed at three second intervals to an examinee who had to identify resemblances to pairs two trials earlier. For example, in the sequence #1) 2A, #2) 3B, #3) 4A, #4) 3A, #5) 4A, the examinee has to recall that trial #3 resembles trial #1 in the dimension of letter, trial #4) resembles trial #2 in the dimension of number, and trial #5 resembles trial #3 in the dimensions of number and letter. The examinees practiced these recalls, 20 trials at a time, each trial exposure being three seconds. Over a period of several sessions, performance increased and error rate decreased, the criteria for atomic skill competency. The surprising result was that the practice also increased general fluid intelligence. We attribute this to the multi-dimensionality of the recall, which required that two dimensions, number and letter be recalled. Such multi-dimensionality requires executive function and it is not surprising that executive function increases intelligence.

2.3 The Executive-Function Approach to Pedagogy

We are now in a position to give a full statement of our approach to pedagogy.

The role of the instructor, or alternatively, the goal of instruction, is

- *a) To identify the atomic skill competencies of a domain of knowledge,*
- *b) To provide exercises and other resources to enable mastery of these atomic skill competencies,*
- *c) To present higher cognitive problems requiring choosing between, and combining of, multiple dimensions - each dimension consisting of a single atomic skill competency – to achieve desired solution outcomes.*

Examples will be presented in the remaining sections of the paper. For the moment we note consistency and correlation of the executive-function approach with the Bloom-Anderson approach since performance of atomic skill competencies corresponds to the lower order Bloom-Anderson levels of knowledge and comprehension while the analysis of multi-dimensional problems corresponds to the higher order Bloom-Anderson levels of analysis (into component dimensions), synthesis and evaluation (determining which competing dimensions drive outcomes).

We have deepened the understanding of Bloom-Anderson by adding specificity, mechanistically identifying the terms *synthesis*, *analysis* and *evaluation* with multi-dimensional processing and by further identifying *knowledge* and *comprehension* with atomic skill competency.

3 EXAMPLES: MODELING

In the next four sections we illustrate application of the executive function approach of pedagogy to several disciplines. In this section, we apply the executive-function approach to modeling of verbal problems. Modeling is a key example of higher order thinking skills and is frequently mentioned in discussions of educational reform [24].

The key point to emphasize about modeling is that it requires a continual multi-dimensional processing of the two dimensions of algebra and language. This is illustrated in Figure 3.

English	**Math**
Amy purchases	
4 Peanut bags	4P
And	+
1 orange juice quart	1O
For a total of	=
6 dollars	6
Bonnie purchases	
1 peanut bag	1P
And	+
4 orange juice quarts	4O
For a total of	=
9 dollars	9
How much does	Solve for
1 peanut bag	P
And 1 orange juice quart	Q
Cost?	

Figure 3: Verbal modeling of a purchase problem with the two equations 4P+1Q=6, 1P+4Q=9. The table should be read both vertically (English, Math) and horizontally (English-Math correspondence)

English Phrase	**Mathematical Correspondent**
And	+
For a total of	=
Number followed by noun	Number x Noun symbol

Figure 4: Small list of verbal-algebraic skill competencies.

Figure 4 illustrates a small list of atomic skill competencies. I have found this approach – creating verbal-algebraic tables – extremely useful when teaching modeling to remedial students. Some would argue that I am replacing thinking with memorization of lists. But a deeper analysis shows this untrue. We have already cited results [15] that memorization can increase intelligence provided executive function is involved. Figure 4 illustrates such a memorization since it requires the two dimensions of language and mathematics. Figure 4 should be perceived as an *exercise* of executive function. I have seen, that after students successfully memorize Figure 4, they are more adept at new English-Math translation situations.

4 EXAMPLES: COLLEGE WRITING

There are a variety of approaches to textbooks on college-writing. The Jones-Faulkner [17] textbook uses executive-function pedagogy. The book leaves grammar to an appendix!

The body of the book is organized into 3 major parts: sentences, paragraphs and essays. Each part is highly skill driven.

For example, there are 4 categories of sentence-pair types, each category having several subtypes. Typical examples of sentence-pair types are sentences connected by *cause, consequence, contrast, analogy, illustrative lists, supporting data, etc.* Consequently, the first part of the book is devoted to developing skill competencies on sentence pairs. A typical exercise might present several sentences and request creating a second sentence that is a consequence of it. The second part of the book develops skills in the five types of paragraphs. After mastering these skill competencies students are adequately prepared to write complex essays.

Figure 5 illustrates the approach of the book. It presents a paragraph and analyzes the sentence-pair relationships.

Paragraph	**Sentence Pair Relationships**
(1) Jim passed several actuarial exams. (2) He was immediately hired. (3) (3a) His success was due to (3a) taking good prep courses and (3b) spending a lot of time studying and practicing. (4) Indeed, during his period of study he did not go to any parties.	#1 – Topic sentence. #1,#2 – Consequence #3,#1 – Cause #4,#3 – Supporting data #3a,3b – Parallel sentences #3b – List of items/examples

Figure 5: Illustrative paragraph and corresponding atomic skill competencies. For example, sentence #2, *Jim being hired*, is the consequence of sentence #1, *his passing actuarial exams*. Similarly, sentence #3- *his taking good prep courses* – is the cause of sentence #1 – *his passing actuarial exams*.

5 EXAMPLE: ACTUARIAL MATHEMATICS

To illustrate the issues in teaching actuarial mathematics, consider the following problem:

5.1 **An Illustrative Example**

Price, (*that is ascertain how much money is needed in the bank*) *an annuity that pays $5,000 at the end of year 1, $5,000 at the end of year 2, $5,000 at the end of year 3, $6,000 at the end of year 4, $7,000 at the end of year 6 and $8,000 for year 7.*

Executive-function pedagogy requires identification of the atomic skill competencies. There are 3 basic annuities which a student must learn to price: *level, increasing, decreasing.*

- Level: A level annuity makes a level payment of $*x* at the end of every year for *n* consecutive years.
- Increasing: An annuity which pays $*x* in the first year, $2*x* in the second year, $3*x* in the third year etc.
- Decreasing: An annuity which pays $*nx* in the first year, $(*n-1*)*x* in the 2nd year, etc. until paying $*x* in the *n*-th year.

Students are taught to recognize these basic three annuities, to calculate their purchase price, as well as the symbols and formula associated with them. These are atomic skill competencies since with sufficient practice students can do any of the three basic annuities i) quickly and ii) without error.

The major part of my teaching is devoted to multi-dimensional analysis of verbal problems, such as the problem introduced at the beginning of this section. One possible multi-dimensional analysis of the problem at the beginning of this section is presented in Figure 6. As can be seen, the sum of two of the three basic annuities – level and increasing – results in the desired payment.

Time	0	1	2	3	4	5	6
Desired payment		5000	5000	5000	6000	7000	8000
Level annuity		5000	5000	5000	5000	5000	5000
Increasing annuity		0	0	0	1000	2000	3000
Sum of level and increasing annuity		5000	5000	5000	6000	7000	8000

Figure 6: Analysis of the desired payments (row (2)) into 2 basic components,a level annuity(row(3) and an increasing annuity (row(4)), whose sum (row(5)) is the desired payment.

In a certain sense, my classroom is flipped: I don't spend time on formulae but rather spend time doing analysis and ask the students, after a brief introduction, to learn and practice formulae on their own.

5.2 **Comparisons with other textbooks**

Kellison edition 2 [18]: a highly respected book that had no competitors for over 10 years, teaches the three basic annuities in the body of the text but only presents multi-dimensional problems such as the example presented in section 5.1, in the exercise section. This approach is used by many textbooks: minimal skills are presented in the text body but analysis and synthesis in the exercises. We advocate the reverse: the majority of textbook and class time should be spent on analysis.

Daniel-Valeer [27]: This textbook presents in the text body both multi-dimensional and atomic skill examples. However, this textbook ingeniously creates a new formula – a new atomic skill competency – that can "solve" two-dimensional problems. Thus the multi-dimensional problems are solved with a *formula* and hence they lose their multi-dimensional challenge.

In summary, it is possible to base an actuarial course on executive function. However, many textbooks prefer to opt the easy way out by leaving students to think on their own or by substituting formulae for thinking.

6 LITERARY CRITICISM AND FOREIGN LANGUAGE

6.1 **Overview on Rashi**

The material in this section is based on the biblical commentary of Rashi. Rashi is an acronym for Rabbi Isaac Solomon. Although many scholars in several civilizations had commented on the Bible [3], Rashi, a French medieval commentator of the 11th century, was the first commentator to comment both on general literary issues as well as individual words and phrases [5,21].

The derivation of each Rashi comment from the Biblical text has been the subject of much research by many people over several centuries. In this paper, we focus on the fact that rules governing Rashi derivations can be organized into ten categories each of which is composed of atomic skill competencies involving executive function [23].

6.2 Rashi and Executive Function

We have already identified executive function with multi-dimensionality. We can organize the Rashi rules according to their multi-dimensionality as presented in Figure 7.

- Two Dimensionality in
  - Words – *meaning, grammar*
  - Phrases – *reference, parallelism, contradiction*
  - Sentences (*Broad/literal interpretation*)
  - *Paragraph structure* (e.g. climax)
  - *Languages*
- Multi (more than 2)-Dimensionality
  - *Database methods*
  - *Symbolism*

Figure 7: The 10 categories of Rashi rules (italicized) organized by dimensionality and essay units (words, phrases, sentences).

6.3 Examples

Hyponymy [32]: Translation is typically thought of as a non-executive function activity. But in Section 2.1 we showed that even a mundane exercise like alphabet recitation can be transformed into executive function quality if it becomes multidimensional. And indeed, Rashi typically comments on word-pairs involving several dimensions.

Rashi, in his commentary on the grain offerings described in Leviticus 2, explains two Hebrew words describing the cooking utensils, *pot* and *frying pan*: *"A frying pan is flattened while a pot has height.*" Frying pans and pots are hyponyms of the hypernym cooking utensil. By translating hyponym pairs, Rashi introduces multi-dimensionality since meaning is based on the two dimensions of *function* (cooking) and *form* (height).

Hononymity: On the verse (Gen. 42:23), *They were unaware that Joseph heard since he had used a translator*, Rashi states that "*In this sentence, heard means understand.* In other words *hear* **hononymically** can refer to listening or understanding. Here again Rashi introduces multi-dimensionality since meaning is based on the two dimensions of *function* (understanding) and *form* (listening).

Grammar: Rashi also used word pairs to illustrate grammar. On the verse (Ex. 19:18) *And mount Sinai was fully smoked* Rashi comments *Smoke is a noun and verb while smoked is an adjective.* Here, Rashi introduces multi-dimensionality since meaning is based on the two dimensions of grammatical function (noun-verb) and spelling (smoke vs. smoked).

Grammar: The text of Num. 12:1 when translated properly reads, *Miryam and Aaron speaks against Moses.* Note the grammatical anomaly indicated by the underlined *s;* proper English is either *Miryam speaks* or *Miryam and Aaron speak* but not *Miryam and Aaron speaks.*

Rashi resolves this contradiction, between a plural subject and singular predicate, by stating *Miryam initiated the conversation while Aaron only echoed and participated Miryam's requests.* Here Rashi introduces multi-dimensionality by modifying the dimension of plural dialogue with a dimension of intensity of plurality (mutual dialogue, or initiated-echo dialogue).

Reference: On the innocuous looking verse (Deut. 26:5) *Jacob went down to Egypt with a few people* Rashi references Gen. 46 which lists the 70 people that went down to Egypt. Hence, the terse but executive-function comment: *Few means 70.* Here, Rashi introduces multi-dimensionality by merging the implications of *two* separate texts.

Parallelism: Unlike the *reference* method where the two texts have few words in common (the reference is based on meaning), in the *parallelism* method the two texts are almost identical; minor differences between the two texts illuminates meaning. Here multi-dimensionality is achieved through simultaneous awareness of two phrases. Figure 8 is illustrative.

[In the Messianic era] *One washes clothing in wine and*
Suth in blood of grapes.

Figure 8: Parallel structure of Gen. 49:11.

The parallelism shows *wine* parallel with *blood of grapes* and *clothing* with *suth.* Hence the terse Rashi comment: *Suth refers to a type of clothing.*

Contradiction: Num..8:24 and Num. 4:2 discuss the age when Levites start working in the Temple: One verse says they start at age 25, while the other states they start at 30. Rashi resolves the contradiction: *They start a 5 year training program at 25 and upon completion at 30, start actual Temple service.* Again, Rashi introduces multi-dimensionality by focusing on multiple texts and multiple dimensions of Temple service.

Two languages: Rashi explains the peculiar biblical word *totafoth: It means 4 since path in African means 2 and Tot in Caspian means 2.* [The word *totafoth* refers to the 4-chambered Tefillin ornament worn by religious people]. Here Rashi introduces multi-dimensionality since multiple languages are being used to explain meaning.

Database: Databases definitionally study relations across multiple dimensions. A rather beautiful example is found in the Rashi commentary on the multi-colored Leviticus 10, a biblical chapter describing i) the death (by God) of Aaron's two sons who impetuously offered an improper sacrifice, ii) Aaron, the High Priest's silence and acceptance of his sons' death, and iii) the Divine command to Aaron prohibiting drunk priests serving.

Rashi performs a simple database inquiry: how are biblical paragraphs introduced: *Several dozen biblical paragraphs of God's laws begin with the introductory sentence "God spoke to Moses to say over", while only two paragraphs begin with the introductory sentence "God spoke to Aaron, to say over." This anomaly suggests the following reasonable sequence of events: Aaron's two sons were drunk; they therefore thought they were as good as their father and could offer anything he could offer. When they did so, they died at the hand of God. As a reward for Aaron's acceptance of God's will, evidenced by his silence, he was rewarded with teaching the commandment that priests should not serve drunk.*

7. REFERENCES

[1] Anderson, P.J., "Toward a developmental model of executive function," In V. Anderson, R. Jacobs & P.J. Anderson (Eds.), **Executive functions and the frontal lobes**, New York: Psychology Press, 2008, pp. 3–21.

[2] L. W. Anderson and D. R. Krathwohl (editors), **A taxonomy for learning, teaching and assessing: A revision of**

Bloom's Taxonomy of educational objectives: Complete edition, New York: Longman, 2001.

[3] Adele Berlin, Marc Zvi Brettler, Michael Fishbane **The Jewish Study Bible: Featuring the Jewish Publication Society Translation**, Oxford University Press, 2004.

[4] B. S. Bloom and D. R. Krathwohl, **Taxonomy of educational objectives: The classification of educational goals, by a committee of college and university examiners. Handbook 1: Cognitive domain**, NY , Longmans, 1956.

[5] Samuel Blumenfield, **Master of Troyes**, N.Y.: Behrman House Publishers, 1946

[6] C. R. Bowie and P.D. Harvey, "Administration and interpretation of the trail making test," **Nature Protocols**, Vol. No. 5, 2006, pp. 2277–2281.

[7] J. D. Corrigan and M. S. Hinkeldey, "Relationships between parts A and B of the Trail Making Test," **J. Clin. Psychol.**, Vol. 43, No. 4, 1987, pp. 402–409.

[8] www.asc-cybernetics.org/foundations/definitions.htm

[9] www.asc-cybernetics.org/foundations/cyberneticians.htm

[10] R. Gagne, **The Conditions of Learning**, New York, New York: Holt, Rinehart and Winston, Inc., 1965.

[11] E. A. Gaudi no and N. K. Squires, "Construct validity in the Trail Making Test: What makes Part B harder?" **J Clin. Exp. Neuropsychology**, 17 (4), 1995, pp. 529-535.

[12] Heaton, R. K., Chelune, G. J., Talley, J. L., Kay, G. G., & Curtiss, G., **Wisconsin Card Sorting Test Manual: Revised and expanded**, Odessa FL: Psychological Assessment Resources, 1993.

[13] K Hess, "Applying Webb's Depth Of Knowledge Levels in Reading,"www.nciea.org/publications/DOKReading_KH08.pdf , 2004

[14] K Hess, "Applying Webb's Depth Of Knowledge Levels in Science," www.nciea.org/publications/DOKScience_KH08.pdf, 2006.

[15] Susanne M Jaeggi, Martin Buschkuehl, John Jonides, Walter J. Perrig, "Improving Fluid Intelligence with Training on Working Memory," **Publications of the National Academy of Science, PNAS Early Edition**, www.pnas.org/cgi/doi/10.1073/pnas.0801268105, 2008.

[16] Jensen, A.R., & Rohwer, W.D. Jr, "The Stroop colorword test: A review," **Acta Psychologica**, 25, 36–93, 1996.

[17] Alexander E. Jones and Claude W Faulkner, **Writing Good Prose: A Simple Structural Approach, Edition 4**, Prentice Hall, 1979.

[18] Stephen G. Kellison, **The Theory of Interest, 2nd edition**, McGraw Hill, NY 1991 pp. 58-94.

[19] Gordon D. Logan, "Toward an Instance Theory of Automation," **Psychological Review**, Vol 95, 1988, pp 492-527

[20]R. J. Marzano, **Designing a new taxonomy of educational objectives**, Thousand Oaks,CA: Corwin Press, 2000.

[21] Aron Owen, **Rashi: His LIfe and Times**, London Jewish Religious Educational Publications, 1955.

[22] Sabrina Pickens,Sharon K Ostwald,Kathleen Murphy-Pace, Nancy Bergstrom, "EVIDENCE SYNTHESIS: Systematic review of current executive function measures in adults with and without cognitive impairments," **International Journal of Evidence-Based Healthcare**, Vol 8 #3, 2010, pp 110-125

[23] Rashi website, www.Rashiyomi.com

[24] **The Common Core State Standards**, http://www.CoreStandards.Org

[25] J Ridley Stroop, "Studies of Interference in Serial Verbal Reactions," **Journal Of Experimental Psychology**, 18, 1995, pp. 643-662.

[26] Maggie Toplack, Richard West, and Keith Stanovich, "Practitioner Review: Do performance based measures and ratings of executive function assess the same construct," **Journal of Child Psychology and Psychiatry**, 54(2), 2013, pp. 131-43.

[27] Leslie Jane Federer Vaaler and James W. Daniel, **Mathematical Interest Theory, 2nd edition**, Mathematical Association of America, 2009, pp 109-177.

[28] P. M. Van-Hiele, **Structure and Insight**, Orlando, Florida: Academic Press, 1986.

[29] N Webb, **Research Monograph Number 6: Criteria for Alignment of Expectations and Assessment on Mathematics and Science Education,** Washington DC: CCSSO, 1997.

[30] 27 N Webb, **Research Monograph # 18: Alignment of Science and Mathematics Standards and Assessment in Four States**, Washington DC: CCSSO, 1999.

[31] N Webb, **Dept. of Knowledge Levels for Four content areas** (Unpublished manuscript), 2002.

[32] The Wordnet project, **wordnet.princeton.edu.**

[33**]** M. A. Yazdani, . "Correlation between Students' Level of Understanding Geometry According to the van Hieles' Model and Students Achievement in Plane Geometry", (online) **Journal of Mathematical Sciences & Mathematics Education**, Vol. 2#1, 2007.

Anticipating Serendipity
Preparing for the Unexpected

Thomas J Marlowe
Department of Mathematics & Computer Science
Seton Hall University
South Orange NJ 07065 USA
thomas.marlowe@shu.edu

ABSTRACT

Serendipity—using "fortunate accidents" for learning or discovery—is a valued if too infrequent route to progress. Although serendipity cannot be scheduled or relied upon, one can develop skills, flexibility and habits of mind that make the recognition and incorporation of serendipitous discoveries more likely. This paper overviews at a high level a program of activities and concepts aimed at preparing modern professionals and communities to leverage the fortunate occurrences they encounter.

Keywords: serendipity, discovery, community, collaboration, improvisation,

1. INTRODUCTION

Serendipity, felicitous acquisition or discovery by a combination of fortune and sagacity, derives from Horace Walpole's correspondence commenting on the fable, The Three Princes of Serendip [33, 36], dating in English from the 18th century. As Walpole states, the three princes were "always making discoveries, by accidents and sagacity, of things which they were not in quest of".

Thus serendipity cannot be a direct goal of a program of discovery, since of course it is impossible to schedule luck, but it is possible to inculcate sagacity, by developing flexibility and an adaptable knowledge base, and fostering openness, wisdom, and judgment.

In the rest of this paper, we look at forms and aspects of serendipity, and suggest an approach for a framework to facilitate it. In particular, we look at the connection of serendipity with improvisation, intuition and analogy.

We then look briefly at a broad variety of applications, and at tools that have been developed for its support. Finally, we provide conclusions and recommendations.

2. FORMS AND ASPECTS

It is possible to recognize three forms (or levels) of serendipity: First, recognition of an unexpected situation or result, as in Goodyear's discovery of vulcanized rubber [10], Fleming's penicillin [37], or Plunkett's Teflon [7]. Second, connections via analogy or linkages, as in Kekulé's (possibly apocryphal) realization of the structure of benzene when he dreamed of a self-devouring snake (the Worm Ouroboros) [35]. And third, the integration of multiple perspectives or disciplines through the formation of groups and communities, where one party's knowledge or approach supplies a missing key to a problem faced by another.

The second, intuitive form, is closely related to the idea of the thought experiment. An interesting example of this form, making totally unexpected connections, occurred in the work of the author. After struggling for months to find an algorithm and complexity analysis for a problem in real-time multi-media scheduling [21], it turned out that the problem was essentially analogous to the line-segment intersection problem [32], which the author had encountered only by taking a course in combinatorial geometry because he found the instructor's approach to teaching appealing.

Dealing with the unexpected is the key to the first two forms. As Isaac Asimov once wrote, "The most exciting phrase to hear in science, the one that heralds new discoveries, is not 'Eureka!' (I found it!) but 'That's funny'" [4]. But to properly deal with the unexpected, one must admit the possibility, and have sufficient mental flexibility, sensory awareness, and "thinking in the background" beyond the immediate task at hand to be able to cope with fortunate surprises.

One must then be able to recognize that something unexpected has occurred, to assess whether the event has the potential to be interesting, and to modify and adapt plans and projects to explore and possibly incorporate the discovery and/or its consequences, and perhaps even changing processes and approaches.

Finally, one must be able to evaluate the result to see if that incorporation was in fact productive, and as necessary to modify and evolve the result, even if it means reverting to the earlier plan or product.

3. THE COLLABORATIVE AND INTERDISCIPLINARY MODE

Collaboration, interdisciplinary ventures, and the community mode in general call not only for such abilities, but also for more group-oriented and communication intensive skills [27]. (Note that "interdisciplinarity" here means more than teams from different disciplines

investigating related problems, or even looking at different facets of a single problem. An interdisciplinary team collaborates as a unit to bring different disciplines to the definition and solution of a problem, development of a product or formation of a community [28]. Such teams can then work with other teams beyond their immediate circle in the pursuit of problem definition and solution.)

First, recognizing opportunities or occurrences requires additional skills: realizing and then fostering a group's potential for positive and creative interaction; picking up on chance but relevant conversations and observations; or making unexpected connections based on conferences, workshops or (formal or informal) publications. An important point, especially for projects complicated by factors such as interdisciplinarity, longevity, complexity or risk, is appreciating unexpected viewpoints and stakeholder perspectives—or sometimes just expected views stated in unexpected ways—which through use of analogy and transformation can produce not only opportunities for integration, but unexpected insights on one's own perspective.

As these connections are made, one finds oneself in a network of overlapping and interacting communities, where "community" can include not only social and governmental units, or enterprises, professional societies or multi-organizational project teams, but also less formal communities of learning, knowledge or practice, as well as "communities of communities", raising the bar from collaborating individuals to collaborating institutions or groups, with a need for both standards and constraints [15].

Preparing to encounter and leverage fortunate occurrences in this mode relies primarily on two factors. After identifying the prospective community or community of communities, the first is creation and maintenance of an environment of communication and trust, which in turn relies on understanding differences in social, institutional, domain/discipline and work cultures [26, 29].

The second is awareness of and openness to the content of communication. Sometimes the most interesting results arise from fortunate misunderstandings, or from attempts by novices (students, interns, participants from outside the discipline) to formulate the principles and issues in a given problem or situation. Once more, the process of analogy, linking disciplines, and pattern matching is important in different ways both for the novice and for the more experienced listener.

In some well-known cases (for example, [3]), the misunderstanding is on the other side, with the novice solving an "impossible" problem by taking a new tack, because he/she did not realize how hard it was or what the traditional approaches had been.

4. A FRAMEWORK

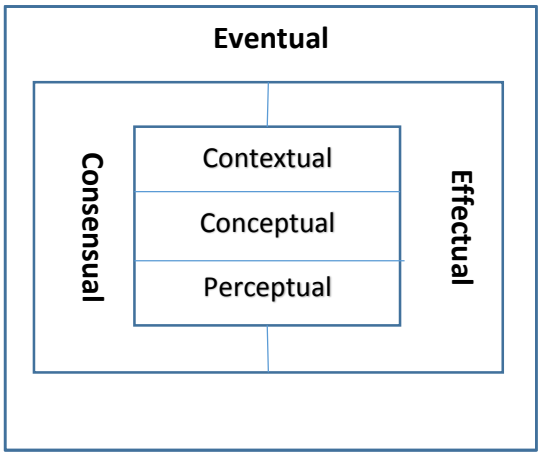
As a structure for organizing the process of being open to serendipity, we propose a framework of six facets: contextual, conceptual, perceptual, effectual, consensual, and eventual. All are valuable, perhaps necessary, for "fortunate discovery", although the perceptual is more valuable in the individual modes, and the consensual in the collaborative modes.

The first three provide core background. The contextual facet is concerned with the acquisition and organization of knowledge [15] — explicit, undocumented implicit knowledge, and tacit, "hand" or "social" knowledge—together with problem analysis (cost-benefit, requirements and risk [23]) and initial problem evaluation—does a prospective approach seem interesting, useful or sufficiently offbeat as to be intriguing?

The conceptual facet entails problem solving and thinking skills: critical thinking, openness and flexibility together with an understanding of agile approaches and processes [2]. In addition, it stresses the understanding and use of analogy [12, 13, 14] and development and use of intuition [8].

While sensory awareness is important to the perceptual facet, the development of a sense of fun with ideas, relationships and communication, and an awareness of physical and social relationships are also important. Improvisation and role-playing [20] are important tools here, especially when the approach emphasizes initial planning and subsequent revision, together with experimentation and exploration of the senses, ideas and relationships. This facet also leads to better communication skills—also valuable in organizing one's own thoughts—listening, organizing information and persuasion, plus a sense of voice, posture and physical presence.

Figure 1. The Serendipity Framework



Surrounding these three foundational facets are two facets corresponding to growing ideas. The first is the effectual

facet, concerned with acquiring and integrating information from multiple sources, disciplines, individuals or groups [15, 22, 18], reaching beyond the familiar, and via multiple modes of perception and communication, which provide grist for the processes of abstraction, specialization and generalization, and analogy.

The second is the consensual facet, involved in working with groups, or within communities of knowledge or practice. The seeds of community development and interdisciplinary discoveries lie in recognizing and fostering prospective communities, inculcating communication and trust, and placing a value on benefits to and healthy growth of the community. The consensual facet also presents opportunities to flesh out ideas, using the community as a forum or sounding board, yet at the same time realizing that there are times when it's appropriate to disregard the opinion or preferences of the community and to go one's own way [1]. Preparing for collaboration also calls for revisiting knowledge management, to incorporate knowledge resulting from integrating partner knowledge, or resulting from a collaboratively developed and operated product [9, 22].

Finally, judgment, revision and evolution comprise the eventual facet, where these should be applied not only to problem solutions, but to the modeling of problems, and to our solution processes themselves, and reflection on one's own thought processes. The eventual facet echoes and reinforces the deepest tasks in the others: contextual problem analysis, the conceptual facet's flexibility and agility, the planning and revision of the perceptual facet, the effectual facet's abstraction, analogy and integration, and both the conditional acceptance and justified rejection of community opinion and approach from the consensual facet. For this reason, success in developing the eventual facet is a good measure of success in anticipating serendipity.

5. APPLICATIONS

Serendipity is an obvious important partner to improvisation in the creative arts—theater, dance, music, and the visual arts—as well as fine and decorative artisanship, including pottery, woodworking, glassblowing and metalwork; the preparation for these domains will be in the same spirit but differ in the details from that described above.

As importantly, and more closely in line with the above, improvisation and readiness to use fortunate occurrences are of immense value across the spectrum of teaching and training [1, 9, 11, 19]. They also are of immense use in software development and development of other knowledge-based products [17], as well as in management, especially of knowledge workers—where knowledge can be understood to include tacit, "hand" knowledge. In each case, the ability to read the "class" and to elicit new information, sometimes not yet articulated by its members, is often beneficial.

Science, engineering and technology workers will also gain from both improvisational skills and preparation for serendipity, as indicated by the examples above, and even more so if in collaborative environments, or those in which a complex problem must be defined by multiple stakeholders.

As a final example, this preparation should be recommended for those interested in community planning and development or effective provision of social services, or in collection and curation of oral and artifactual history [18, 30].

6. TOOLS AND SUPPORT

Data mining and visualization are useful discovery tools, although typically limited to information already encoded in the given context. As such, they can be adjuncts, revealing existing patterns and suggesting hypotheses, or suggesting new ones as information is added or modified, but don't themselves add to the context. To promote serendipity, these need to be complemented by tools that make contacts and connections, or that suggest analogies.

Automatic or semi-automatic connection of people with common acquaintances or perceived common background or interests is now common on social media such as Facebook™, LinkedIn™ and others. However, it is both more interesting and more useful (from a research perspective) when those connections are made on the basis of shared knowledge or concerns, or when one appears to have knowledge that will be useful to the other (and hopefully vice-versa), and the results are integrated with enterprise knowledge management.

A number of tools [5, 6, 31] have been developed to support development of a knowledge base with such cross-connections, and the making of connections between people and groups, or between people/groups and topics, using shared technical contacts, publications, projects, and declared interests and memberships to do so. The more sophisticated tools will examine publications and projects to attempt to discover shared techniques, algorithms, concepts, or concerns. Others focus more explicitly on creating a semantic net of concepts labelled with references or artifacts, and notifying interested parties of new connections [34].

An integrated tool for support of collaboration and innovation is presented in [18, 25]. This tool includes both the knowledge and connection base described above, but tools for sharing views of a project across organizations, and robust communication tools. (See also [16, 24], describing a system for software development that integrates project artifacts with collaborator and external information.)

Analogy generating tools are less common, mostly exist in the world of artificial intelligence [13], and are limited both by incomplete context and by a necessarily incomplete analogy-forming rule-base [14]. The author is unaware of any current tool that combines AI-based analogy generation with the sort of connection former described above.

7. CONCLUSIONS

Although one cannot schedule or rely on serendipity, one can develop the flexibility, mental attitudes and skills to improve the likelihood that one will recognize and benefit from fortunate accidents when they occur.

The program of development should include traditional exercises to develop critical thinking and problem solving, together with requirements and risk elicitation and evaluation. These can be specialized to the domain(s) of the participants, with the goal of forming a deeper and more conceptual understanding of its structures. To these can be added study of (general or domain-specific) patterns, the abstraction-generalization-specialization approach, and the use of analogy, and other activities designed to foster intuition, as well possibly as more general surveys of semiotics or visualization.

But these should be supplemented with approaches aimed at fostering communication and creativity, such as improvisation, and with community and group development workshops, and each of these aspects should deal with trust building and differences in cultures, in the broadest sense of that term. Finally, these need to be supplemented with activities that strengthen the analytical facility of the participants as applied to assessing the initial and eventual values of problem, process, and patterns of thought.

The facet structure proposed above will be useful in a broad evaluation of such a program of activities, and may assist in staging, sequencing and refining its activities.

Naturally, large knowledge enterprises and teams involved in multiple complex and interdisciplinary projects will also want a tool suite to facilitate organizing knowledge, making unanticipated connections of both people and information, and evaluating and testing proposed designs or solutions. The combination of preparation, continuing interaction and tool support will facilitate the entire (possibly collaborative) enterprise, and recognition and leveraging of serendipitous occurrences.

Acknowledgments: The author wishes to acknowledge the contributions of Dr. Vassilka Kirova of Alcatel-Lucent and Dr. Susu Nousala of Aalto University.

References

1. Aalto University, Creative Sustainability Aalto Lab Summer School, http://acs.aalto.fi/category/cs-experience/?filter=challenging-the-mindset
2. Agile Consortium, *Agile and Business*. Accessed August 10, 2012 at http://agileconsortium.blogspot.fr/2007/12/nokia-test.html Archived at http://www.webcitation.org/6Ij7bTlDe
3. Albers, Donald J. and Constance Reid, "An Interview of George B. Dantzig: The Father of Linear Programming", **College Mathematics Journal**, 17 (4), 293-314, 1986. See http://www.snopes.com/college/homework/unsolvable.asp#hisZzlhgpVQHkJO.99
4. I. Asimov, Accessed August 3, 2014 at http://www.quotationspage.com/quotes/Isaac_Asimov.
5. O. Barkol, R. Bergman, K. Kasravi, S. Golan, M. Risov, "Enterprise Collective: Connecting People via Content", *CENT 2012: 2nd International Symposium on Collaborative Enterprises, in conjunction with WMSCI 2012*, July 17-20, 2012, Orlando FL, USA.
6. R. Bergman, "Enterprise IT as Knowledge Keeper", keynote, *CENT 2012: 2nd International Symposium on Collaborative Enterprises, in conjunction with WMSCI 2012*, July 17-20, 2012, Orlando, Florida, USA. Accessed August 3, 2014 at http://www.iiis.org/ViewVideo2012.asp?id=16.
7. Chemical Heritage Foundation, *Roy J. Plunkett*, Accessed August 3, 2014 at http://www.chemheritage.org/discover/online-resources/chemistry-in-history/themes/petrochemistry-and-synthetic-polymers/synthetic-polymers/plunkett.aspx.
8. D. Dennett, **Intuition Pumps and Other Tools for Thinking**, W.W. Norton, 2013.
9. C. Garduño, S. Nousala, "Aalto LAB Mexico, a Knowledge Exchange Experiment in Design Education", *Knowledge and Cognitive Science and Technologies II (KCST / RMCI), WMSCI*, Orlando FL USA, 13-18, July 2014.
10. Goodyear Corporate, The Charles Goodyear Story, Accessed at August 3, 2014, http://www.goodyear.com/corporate/history/history_story.html.
11. N. Hayden, Classroom Improvisation Activities, Accessed 27 February 2014, http://www.ehow.com/info_7915839_classroom-improvisation-activities.html.
12. D. Hofstadter, **Gödel, Escher, Bach: An Eternal Golden Braid**, Basic Books, 1980.
13. D. Hofstadter, the Fluid Analogies Research Group, **Fluid Concepts and Creative Analogies: Computer Models of the Fundamental Mechanisms of Thought**, Basic Books, 1995.
14. D. Hofstadter, E. Sander, **Surfaces and Essences: Analogy as the Fuel and Fire of Thinking**, Basic Books, 2013.
15. N. Jastroch, V. Kirova, T.J. Marlowe, S. Nousala, "Complex Collaboration, Knowledge Sharing and Interoperability," *18th International ICE Conference on Engineering*, Technology and Innovation, June 2012, Munich, Germany.
16. V. Kirova, T.J. Marlowe, C.S. Ku, "Knowledge engineering and colored traceability in global collaborative software enterprises", **Genie Logiciel**, no 107, pp. 39-46, December 2013.
17. V. Kirova, personal communication, 2014.
18. A. Lau, T. Tilebein, T. Fischer, *The Industrial Model of Smart Networks for SME Collaboration—Implementation and Success Stories*, 7th International Conference on Interoperability for Enterprise Systems and Applications (I-ESA), Albi, France, March 2014.
19. J. Mackey, T. Evans, "Interconnecting Networks of Practice for Professional Learning", **International Review of Research in Open and Distance Learning**, 12 (3), March 2011.
20. T.J. Marlowe, "Enhancing Teaching, Adaptability and Presentation Skills Through Improvisational Theater", *12th International Conference on Education and Information Systems, Technologies and Applications (EISTA 2014), in Proc. 8th International Multi-Conference on Society, Cybernetics & Informatics (IMSCI)*, 270-275, Orlando, FL, USA, July 2014.
21. T.J. Marlowe, S. Baruah, "Fairness-preserving degradation in overloaded multimedia conferencing systems", *2004 Conference on Parallel and Distributed Computing Systems (PDCS)*, International Society for Computing Applications, 440–447, September 2004.
22. T.J. Marlowe, N. Jastroch, V. Kirova, M. Mohtashami, "A Classification of Collaborative Knowledge," *Workshop on*

Collaborative Knowledge Management, Workshop on Knowledge Generation, Communication and Management (KGCM 2010), 13-18, Orlando FL, USA, July 2010.
23. T.J. Marlowe, V. Kirova, M. Mohtashami, "A Strategy for Improving Curricular Coverage of Problem Solving Through Emphasis on Requirements Analysis", *44th Annual Meeting of the Design Sciences Institute (DSI 2013)*, Baltimore MD, November 2013.
24. T.J. Marlowe, V. Kirova, M. Mohtashami, "Enhanced Incubators: Fostering Collaboration, Growth and Innovation", *7th International Conference on Interoperability for Enterprise Systems and Applications (I-ESA)*, Albi, France, March 2014.
25. H. Matheis, A. Lau, M. Hirsch, Technological Support for Managing Collaborative Innovative Projects in SME Networks, in: Cunningham, S. W., Salimi, N., Ortt, R., Rezaei, J. and B. R. Katzy, eds., *Conference Proceedings of the IEEE Technology Management Conference & 19th ICE Conference*, The Hague, The Netherlands, 24-26th June, 2013.
26. M. Mohtashami, T.J. Marlowe, V. Kirova, F. Deek, "Risk-Driven Management Contingency Policies in Collaborative Software Development," **International Journal of Information Technology and Management**, Volume 10 (2-4), p 247-271, 2011.
27. I. Mulder, Beyond Boundaries: The Networked Collaboration Canvas, workshop, 19th ICE & IEEE-ITCM 2013.
28. S. Nousala, A. Miles, B, Kilpatrick, W.P. Hall, "Building knowledge sharing communities using team expertise maps" **International Journal of Business and Systems Research**, 3 (3), 2009.
29. S. Nousala, A. Moulet, B. Hall, A. Morris, "A poly-disciplinary approach: A creative commons for social complex adaptive systems", Book of Abstracts, *European Conference on Complexity Systems (ECCS 2012)*, p 79, 2012.
30. S. Nousala, "What could future learning structures look like and why would we care? The praxis of complex adaptive systems and learning structures", **EMC SR 2014 Book of Abstracts**, 2014.
31. M. Pallot, K. Pawar, R. Santoro, "Connective Experience Co-Creating a Semantic Enabled Serendipity Service for Living Labs and the Internet of Things", in: Cunningham, S. W., Salimi, N., Ortt, R., Rezaei, J. and B. R. Katzy, eds., *Conference Proceedings of the IEEE Technology Management Conference & 19th ICE Conference*, The Hague, The Netherlands, 24-26 June, 2013.
32. F.P. Preparata, M.I. Shamos, **Computational Geometry: An Introduction**, Springer Verlag, 1985.
33. T.G. Remer (Ed.), ***Serendipity and the Three Princes of Serendip; From the Peregrinaggio of 1557***. University of Oklahoma Press, Norman, OK, 1965.
34. M. Taramigkou, E. Bothos, D. Apostolou, G. Mentzas, "Fostering Serendipity in Online Information Systems", in: Cunningham, S. W., Salimi, N., Ortt, R., Rezaei, J. and B. R. Katzy, eds., *Conference Proceedings of the IEEE Technology Management Conference & 19th ICE Conference*, The Hague, The Netherlands, 24-26 June, 2013,
35. M. Verdresse, H. D. Roth, Kekulé's Dream, Accessed August 3, 2014 at http://web.chemdoodle.com/kekules-dream.
36. H. Walpole, references to the Three Princes of Serendip [33], **Horace Walpole's Correspondence,** cited in http://livingheritage.org/three_princes.htm, accessed August 3, 2014.
37. Wikipedia, Alexander Fleming. Accessed August 3, 2014 at http://en.wikipedia.org/wiki/Alexander_Fleming.

AN INTER-DISCIPLINARY LANGUAGE FOR INTER-DISCIPLINARY COMMUNICATION: ACADEMIC GLOBALIZATION, ETHOS, PATHOS, AND LOGOS

Marta Szabo WHITE
Department of Managerial Sciences,
Georgia State University
Atlanta, Georgia 30303, USA

ABSTRACT

Inspired by the intersection of character, emotions, and logic, much like a Hungarian Rhapsody which is beautifully sad; this paper explores ethos, pathos, and logos in the context of Academic Globalization**.** As students of the world, an inter-disciplinary language is pivotal for inter-disciplinary communication.

Given that the current state of the world stems primarily from miscommunications, it is imperative to launch a cognitive language tool which underscores global commonalities and mitigates cultural differences. Such a platform would foster interdisciplinary research, education, and communication.

New paradigms would evolve, grounded in ethos, pathos, and logos. Like yin and yang, these states are interrelated, interacting, and interchanging learning spheres. Just as day and night blend at some point; just as the Parthenon epitomized Greek thought, celebrated the birthplace of democracy, and for the first time, depicted everyday citizens in friezes- underscoring their impactful role- ethos, pathos, and logos represent cross-disciplinary communication devices which synergistically transform and ignite academic globalization.

The Literature Review links the concepts of ethos, pathos, and logos with the seminal work Lewis and his LMR framework, which has given birth to Cultureactive and subsequently to ICE [InterCultural Edge]. http://www.fuqua.duke.edu/ciber/programs/we_organize/ice/ Accessed February 14, 2014

PROPOSITION

Particularly relevant to this paper is the fact that the Parthenon columns are slanted inwards, and if extended into the sky, would intersect at about one mile above the earth. This extension beyond traditional thought and subsequent intersection represent character/credibility (ethos), emotion (pathos), and logic (logos). Moreover, Lewis' LMR framework, i.e. Linear-active, Multi-active, and Reactive, are the vehicle for an inter-disciplinary language which enables interdisciplinary communication.

In conclusion, this paper suggests that extending the LMR framework beyond conventional boundaries provides the foundation for inter-disciplinary language and thus fosters inter-disciplinary communication. Ethos, pathos and logos accelerate a rich communication platform, within the context of Academic Globalization.

Keywords: Globalization, International Business, Culture, Strategic Management, Communication, Leadership, Decision-making

LITERATURE REVIEW

The origin of ethos, pathos and logos began over 2,000 years ago:

The Greek philosopher, Aristotle argued that persuasion can be divided into three categories: ethos, pathos and logos [18] & [19].

Ethos [Greek for character]
Ethical Appeal – Persuasion emanates from the credibility, authority, or reputation of the speaker or writer. An ethos-principled argument is characterized by an appeal based on ethics or credibility.

Pathos [Greek for experience or suffering]
Emotional Appeal – Persuasion is grounded in sympathy, emotion, or instinct. A pathetic story conveys emotion and imagination such that the audience is empathetic with the values and beliefs of the speaker or writer.

Logos [Greek for word]
Logical Appeal – Persuasion rests with reason and refers to an argument's logical appeal. Of paramount importance is the internal consistency of an argument and supporting evidence, e.g. constructs such as if A, then B.

Of seminal importance is HOW something is communicated, not WHAT is communicated. To this end, a review of the LMR framework follows.

ICE PROVENANCE

ICE emerged from another cross-cultural assessment tool, Cultureactive when from a research perspective, validity and reliability issues became increasingly paramount. Grounded in his forty-plus years of cross-cultural consulting, Richard Lewis, who authored *When Cultures Collide* [13] and *The Cultural Imperative* [14], was challenged to explain national, international and transnational business cultures. Poignantly, he conceived the LMR framework, which gave birth to Cultureactive and later ICE [24].

The 1980s propelled an acute demand for cross-cultural instruction, and Richard Lewis, the consultant, was approached repeatedly by multi-national clients for a new and practical cultural/national classification system. For years, cross-culturalists had grappled with the problem of summarizing or simplifying national characteristics. Richard Lewis proposed that cultures could be classified simply and more comprehensively according to the three categories, comprising the LMR framework [13] & [14].

Linear-actives
Cultures which are task-oriented, plan, organize, schedule and pursue one thing at a time (e.g. Germans, Swiss).

Multi-actives
Cultures which are lively, loquacious, multitask, prioritize according to the importance or thrill of the event (e.g. Italians, Latin Americans, and Arabs).

Reactives
Cultures that prioritize courtesy and respect, listen quietly, and react carefully to proposals (e.g. Chinese, Japanese and Finns).

The strength of this framework is that it transcends previous works by focusing on the individual, rather than the nation-state as the unit of analysis. With no assumption of within-country homogeneity, the above hypothesis focuses on actors rather than nations. The focus of the LMR model is

communication, which is often the impediment between and among cultures, and commensurately a key consideration in globalization.

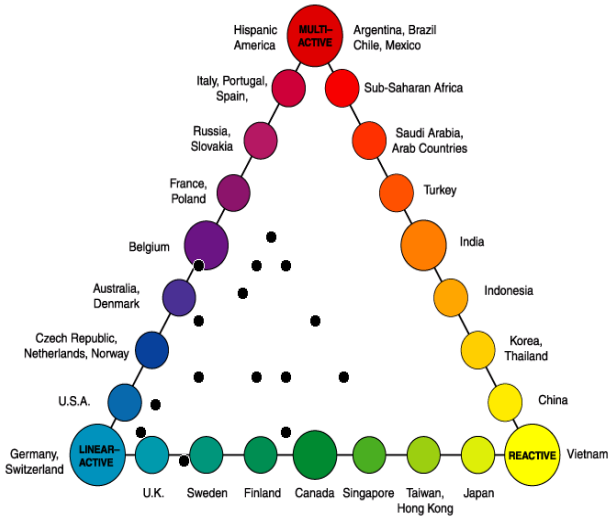
Known as the ABC research team, Adair, Buchan and Chen [1] & [2] capitalized upon both Hall's [8] low context/high context communication tool and Triandis' [22] model of subjective culture to result in the theoretical underpinnings for ICE. The conceptual reconfiguration leveraged the works of Trompenaars [23], Holtgraves [11], Hampden-Turner [23], Thomas and Kilman [20], Yamagishi [25], and Bearden, Money and Nevins [3] in the evolution from the experientially-based Cultureactive to the theoretically-based ICE.

The contribution of this paper is the LMR linkage to the celebrated Greek philosopher, Aristotle, who classified the art of persuasion through ethos, pathos and logos. While the logos appeal was Aristotle's favorite, all three serve to elevate communication to the next aspirational level. Moreover, this trilogy was inspired by Greek thought, in similar fashion to the Parthenon. Aristotle argued for *writing effectiveness*; this paper argues for *interdisciplinary communication effectiveness* enhanced by another trilogy: the LMR framework.

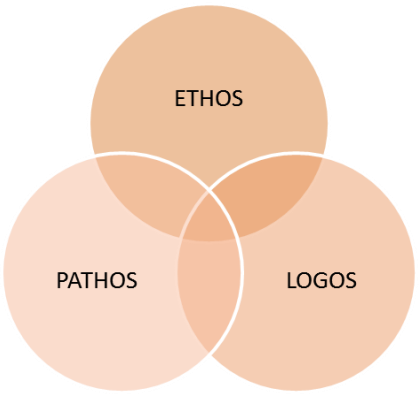
Commensurate with exploring, expanding and energizing international education, interdisciplinary communication and globalization, the LMR framework equips academicians and practitioners with a vehicle for interdisciplinary language. The simplicity of Linear-active, Multi-active, and Reactive constructs trump prior theoretical frameworks for studying cultural differences, which have included the Kluckhohn-Strodtbeck [9], Trompenaars and Hampden-Turner [23], and most notably, Hofstede [10].

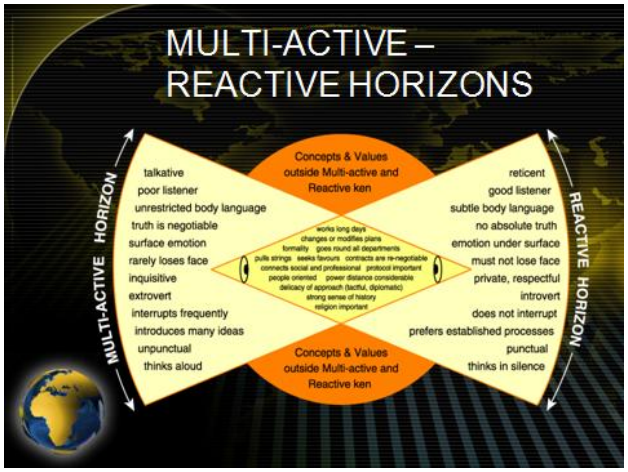
The provenance of Cultureactive and ICE are chronicled in more detail in an earlier paper [24]. ICE is a collaborative initiative between the Fuqua School of Business, Duke CIBER, Richard Lewis Communications, and Cultureactive.com. Cultureactive and ICE are web-based products that teach cross-cultural awareness in business settings by focusing on individual cultural profiles which are then compared to national profiles using the LMR constructs. Participants may analyze personal assessments, team results and national cultural profiles. Research consortia have completed the requisite validity and reliability measures for ICE, and commensurate ICE teaching consortia have established a certified teaching network.

Capitalizing on the LMR framework and integrating the basic components of persuasion- ethos, pathos and logos- [18] & [19], in the spirit of the Parthenon, where the columns intersect above the earth, and projecting this consortium beyond traditional thinking, the following emerges, which is symbolic of interdisciplinary communication:

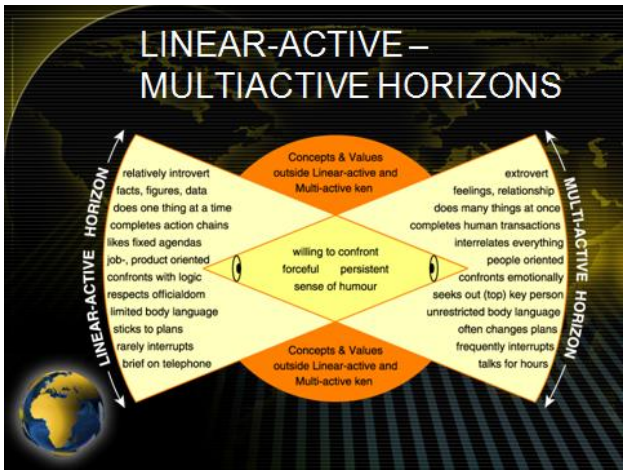


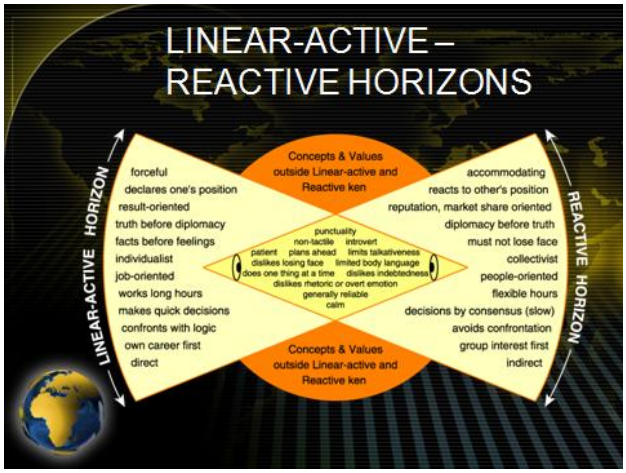
PLUS





EQUALS





LMR CONSTRUCTS COUPLED WITH ETHICAL, EMOTIONAL and LOGICAL ELEMENTS of PERSUASION ELEVATES INTERDISCIPLINARY LANGUAGE to INTERDISCIPLINARY COMMUNICATION

The pivotal role that rhetoric elements of ethos, pathos and logos play in viewing the world through Linear-active, Multi-active, and Reactive constructs allows communication to underscore the commonalities and minimize the differences, resulting in the essence of interdisciplinary communication. This model best captures where academic globalization is headed.

CONCLUSION

In conclusion, this paper builds on the model of the Parthenon in suggesting that the LMR framework in conjunction with Aristotle's elements of persuasion- ethos, pathos and logos – serve to highlight unique horizons of the commonalities of communication as follows:

A Multi-Cultural team represents communication beyond borders, with synergistic strengths greater than any sole component of the LMR model. Grounded in the intersection of two trilogies: Linear-active, Multi-active, and Reactive with ethos, pathos and logos, this paper proposes communicating outside of the box, beyond the triangle, where Parthenon pillars interconnect, and language extends beyond cultures to maximize harmonization and foster interdisciplinary communication.

The LMR framework is a powerful facilitator for cross-cultural communication styles. When linked with Aristotle's modes of persuasion, a new dimension is created, which capitalizes upon synchronization and minimizes differentiations to result in a language rich in interdisciplinary communication.

REFERENCES

[1] Adair, W. L., Buchan, N.R. & Chen, X.P. [Forthcoming]. *Communication and Social Interaction Style across Cultures (CSIS): Conceptualization, Antecedents, and Organizational Consequences.*

[2] Adair, W. L., Buchan, N.R. & Chen, X.P. [In press]. *Bringing views of culture as communication and social interaction into management and marketing research.* In C.Nakata (Ed.) **Beyond Hofstede: Culture Frameworks for Global Marketing and Management**. New York, NY: Macmillan Palgrave.

[3] Bearden, W.O., Money, B.R. & Nevins, J.I. [2003]. Development and validation of a measure of long term orientation, In Money, B.R. and Rose, R.L. [Eds.] **Enhancing Knowledge Development in Marketing,** 14, Chicago, IL: American Marketing Association.

[4] Bond, M.H. [2002]. Reclaiming the Individual From Hofstede's Ecological Analysis- A 20-Year Odyssey: Comment on Oyserman et al. [2002]. **Psychological Bulletin,** 128 [1], 73-77.

[5] Fulbright, W.J. [1989]. **The Price of Empire.** Pantheon Books.

[6] Gómez-Mejía, L.R., Balkin, D.B. & Cardy, R.L. [2004]. **Managing Human Resources.** [4th Ed.]. Upper Saddle River, N.J.: Pearson Prentice Hall.

[7] **Gulliver.** [2000]. Richard Lewis Communications. PricewaterhouseCoopers.

[8] Hall, E.T. [1973]. **The Silent Language.** Garden City, New York: Anchor Press/Doubleday.

[9] Hill, C.W.L. [2003]. **International Business: Competing in the Global Marketplace.** [4th Ed.] Boston: McGraw-Hill/Irwin.

[10] Hofstede, G. [1980]. **Culture's Consequences: International Differences in Work-related Values**. Newbury Park, CA: Sage.

[11] Holtgraves, T. [1997]. Styles of language use: Individual and cultural variability in conversational indirectness. **Journal of Personality and Social Psychology,** 73(3), 624-637.

[12] Jackson, S.E. & Schuler, R.S. [2006]. **Managing Human Resources Through Strategic Partnerships.** Australia: Thomson/South-Western.

[13] Lewis, R.D. [2000]. **When Cultures Collide: Managing Successfully Across Cultures.** London: Nicholas Brealey.

[14] Lewis, R.D. [2003]. **The Cultural Imperative: Global Trends in the 21st Century.** Finland: Intercultural Press.

[15] Mello, J.A. [2006]. **Strategic Human Resource Management.** [2nd Ed.]. Australia: Thomson/South-Western.

[16] Oyserman, D., Coon, H.M. & Kemmelmeier, M. [2002]. Rethinking Individualism and Collectivism: Evaluation of Theoretical Assumptions and Meta-Analyses. **Psychological Bulletin,** 128(1), 3-72.

[17] Ramsey, R.E. & Miller, D.J. [2003]. **"Experiences between philosophy and communication: engaging the philosophical contributions of Calvin O. Schrag".** SUNY Press. p. 21. ISBN 9780791458754. http://books.google.com/books?id=Id7NornoMI8C. Accessed March 2, 2012

[18] Ramage, J.D. & Bean, J.C. [1998]. **Writing Arguments**. [4th Ed.]. Needham Heights, MA: Allyn & Bacon. pp 81-82.

[19] Sproat, E., Driscoll, D.L. & Brizee, A. [2012]. **Aristotle's Rhetorical Situation**. Copyright Â©1995-2014 by The Writing Lab & The OWL at Purdue and Purdue University. https://owl.english.purdue.edu/owl/resource/625/03/ Accessed February 15, 2014.

[20] Thomas, K.W. & Kilmann, R.H. [1974]. **The Thomas-Kilmann Mode Instrument.** New York: NY: Xicom.

[21] Tinsley, C. [1998]. Models of conflict resolution in Japanese, German, and American cultures. **Journal of Applied Psychology,** 83(2), 316-323.

[22] Triandis, H. C. [1972]. **The Analysis of Subjective Culture**. New York: Wiley.

[23] Trompenaars, F. & Hampden-Turner, C. [1998]. **Riding the Waves of Culture: Understanding Cultural Diversity in Global Business**. [2nd Ed.] New York: McGraw-Hill.

[24] White, M.S. [2009]. *Academic Globalization: Universality of Cross-cultural and Cross-disciplinary LMR Perspectives.* **Proceedings of the Second International Symposium on Academic Globalization: AG 2009**, Orlando, Florida, 10-13 July, 2009. **BEST PAPER AWARD**

[25] Yamagishi & Yamagishi [1994]. Trust and commitment in the United States and Japan. **Motivation and Emotion,** 18(2), 129-66.

Towards a General Methodology for Second-Order Science[1]

Karl H. MÜLLER
Steinbeis Transfer Center New Cybernetics
Vienna, A—1160, Austria

ABSTRACT

In recent years a new science frontier emerged under the umbrella term of second-order science which creates new and challenging problems through a characteristic re-entry-operation like in pattern of patterns, learning of learning, cybernetics of cybernetics or logic of logic, which works with and on building blocks or elements of traditional or first-order scientific research and which, due to this re-entry configuration, becomes inherently reflexive.
In this article I will pursue the ambitious goal to develop a general methodology for second-order science which is needed for second-order analyses from their initial stages up to the final steps. This general methodology will be framed as a sequence of recombination operations which become the central task for a particular step in the design of second-order investigations.

Keywords: First-order science, second-order science, re-entry, science levels, reflexivity.

1 INTRODUCTION

The concept of second-order science was proposed as a radical widening and expansion of the traditional scientific landscapes and as a new science frontier with vital functions for the science system in general (Müller & Riegler, 2014). In this article a general methodology will be developed which specifies the necessary steps in second-order analyses. Moreover, two examples for a second-order study will be presented which are both situated within the social sciences and which will specify the concrete instantiations for the general methodological steps.

But before I start the tour to a general methodology of second-order science two brief outlines will be given, one on the architecture of second-order science and one on innovation processes in general which should produce the necessary guidelines and options for the subsequent steps in the general methodology of second-order science.

2 A SHORT OVERVIEW OF SECOND-ORDER SCIENCE

Second-order science is based on a new general architecture for the overall science system which is characterized by different vertical levels or, alternatively, by horizontal domains and on the long-term evolution of a three level configuration.[2] According to this construction scheme, modern science evolved, for centuries implicitly and since the end of the 19th century explicitly, in a three-layered configuration between research domains proper at a first-order level, supporting research infrastructures at a zero-order level and an area of reflexive analyses on scientific research processes and outputs at the second-order level.

- The first-order level of research can be characterized as a problem-solving operation and is designed, on the one hand, for the exploration of the natural and social worlds as well as for the construction of a technological sphere and, on the other hand, for the axiomatization and orderings of the possible worlds of logic, mathematics and related normative fields. The first-order level of research constitutes the usual area for scientific activities. Investigations on empirical themes across nature and society, on technical or technological systems or on normative issues in logic, mathematics, statistics, ethics or aesthetics fall all under the category of first-order science. Approximately 90% of scientific activities are still undertaken at the first-order level. Finally, scientific research at the first-order level can be defined as first-order science.
- The zero-order level constitutes the kingdom of research infrastructures which perform vital catalytic functions of enabling, of accelerating or of improving first-order research. These different catalytic functions are accomplished in three different forms. The first type is based on large-scale observation, measurement and experimental facilities and their production of a rich data variety which contains relevant observations, measurements and experimental data for first-order research. The second form builds and utilizes a rich coded[3] information base which is composed of bibliometric, scientometric, genomic or other encoded elements. Finally, the third type operates with the documentation and the archiving of relevant research data and through the institutionalization of permanent data archives. All three forms combined constitute the zero-order level of science landscapes and the area of zero-order science which, moreover, should increase in relevance during the next decades.
- In contrast, the fields at the second-order level operate on building blocks from the first order domain like experimental results, tests, studies, evaluations, models, methods, theories and the like with scientific means. Research at the second-order level can be organized in a multiplicity of contexts, as will be demonstrated in the subsequent sections. Second-order studies, by exploring new topics and fields at the second-order level, offer important functions for first-order research which will be developed in the course of this article, too[4].

Figure 1 summarizes, once again, the three level-configuration for contemporary science landscapes.

---

[1] This article is dedicated to Alexander Riegler who in recent months was very helpful and supportive to promote the new perspective on second-order science (Riegler & Müller, 2014).

[2] Though this article uses a vertical level description it must be emphasized that the differentiation into three science landscapes can also be conceptualized as well as visualized in horizontal domains as well.

[3] Coded objects comprise publications, gray literature or citations in the science world, but can be extended to coded genetic information in bio-technology, etc.

[4] It must be added that a very small area at the second-order level or domain is reserved for second-order data and information analyses from the zero-order level or domain like meta-data compilations or bibliographies of bibliographies, etc.

Figure 1 A New Architecture of Contemporary Science Landscapes with Three Principal Levels

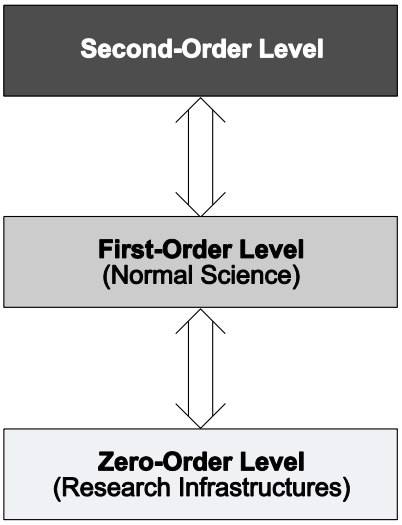
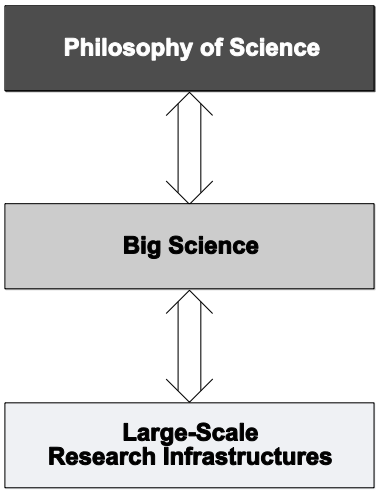


Figure 2 exhibits a stylized image of these three layers around the decades between 1940 and 1960 when trans-disciplinary approaches like systems science, cybernetics or artificial intelligence emerged.

Figure 2 Three Levels of Science-Landscapes around 1950/1960



Following Figure 2, little science entered a period of big science (de Solla Price, 1974) with high levels of production and publication levels. The dominant area at the second-order level was occupied by a small philosophy of science field and the research infrastructures at the zero-order level shifted from their small-scale into large-scale configurations. For example, CERN started its operations with a synchrocyclotron and a proton synchrotron during the 1950s, the nuclear research centre in Jülich was founded in 1956, etc.

At this point it becomes possible to introduce the notion of second-order science as the sum total of research activities that is carried out at the second-order level. Like zero- or first-order science, second-order science is, thus, bound to a specific level of science landscapes.

The next step leads to closer specifications of the second-order level and of second-order investigations. These studies at the second-order level are based on a single operation, which was originally invented by George Spencer Brown, namely on the operation of re-entries. This special operation comes into play whenever elements or building blocks from the first-order level are applied to themselves in the form of

computation of computation, cybernetics of cybernetics, geometry of geometry, linguistics of linguistics, logic of logic, magic of magic, mathematics of mathematics, pattern of pattern, teaching of teaching, will of will. (Kauffman, 2005: 129)

One could add other examples by Heinz von Foerster like understanding understanding, communication of communication, goals of goals, control of control, etc. Usually, these self-referential twists are considered as a playful field or pastime for logicians, mathematicians or philosophers. But these self-applications of first-order science elements accomplish a logical closure, because these elements are not only applied in various external space-time settings, but also to themselves. Whenever such an element is applied to itself such as in understanding understanding, science writing of science writing or learning of learning, the logical realm of applications for these concepts becomes closed (Kauffman, 1987).

Aside from the closure of first-order building blocks like concepts, theories, models, methods, generative mechanisms or scientific fields, a series of arguments can be developed that these re-entries constitute also a vast new science frontier which has been weakly recognized and marginally explored so far. What was mostly ignored until now is the relevance of these re-entries for the creation or production of new scientific areas of investigation.

Using re-entry operations, one can construct a very large number of new research problems and fields at the second-order level.

- The first example of re-entries is focused on re-entries into normative first-order fields. Here, second-order investigations are directed to research problems like a methodology of methodologies, research designs of research designs, a calculus of calculi, an algebra of algebras, rule-systems of rule systems, laws of laws, etc. Usually, these re-entries into normative first-order building blocks generate new topics for second-order investigations and a normative second-order context which lead to normative approaches, frames and tools with higher generality, directed towards the foundations of normative sciences.
- A second example produces re-entries into a single, several or many first-order fields. The social sciences of social sciences can be focused, for example, on social relations between social science disciplines, the environmental sciences of environmental sciences place their emphasis on the environmental relations of environmental science, management science of management science produces second-order management schemes for various traditions of management science, etc. and produces, thus, a new second-order area. Usually, these re-entries into first-order disciplinary domains lead to new and mostly unexplored second-order disciplines, sub-disciplines or hybrid fields.
- The third example focuses on the output context of first-order science and leads to re-entries into the

results, products or, more generally, into the available research outputs of a single field or across many disciplines of first-order research. Here, re-entries can be focused on specific causal relations, distributions, tests, patterns, studies, articles, etc. within a first-order field or across clusters of several fields or disciplines.

- The fourth example is concentrated on the input context like in theories of theories, models of models, methods of methods and the like. As a concrete example, power-law distributions and their underlying generative mechanisms can be transformed into a second-order study of generative mechanisms of generative mechanisms for power-law distributions. Here, the emphasis changes to a search for more general or deeper generative mechanisms which are able to generate different types of generative mechanisms.

These four examples for re-entries should be considered as only a tiny fraction and as a very small set of actual re-entries in a vast number of possible re-entries. In general, re-entries can be used to generate new fields or, as a development for the near future, even new academic disciplines, new, challenging and hot topics for scientific research or more general second-order building blocks compared with their corresponding first-order counterparts.

At this point the question of the purpose and the overall goals of second-order investigations in particular and of second-order science in general must be raised. *Cui bono*? Why bother about second-order science at all? Basically, three core goals or functions can be specified for second-order science. All three goals and functions emerged when the overall science system entered the diversified stage of a three level architecture, accumulated a vast number of first-order studies and publications and was confronted with a growing need for innovation outlets, quality control and a demand for robust knowledge:

- A first goal or function for second-order studies can be specified in terms of innovative and challenging research problems. Through re-entries into first-order building blocks like concepts, theories, models, mechanisms an enormous amount of new, highly challenging and mostly unexplored research problems are generated. Thus, the first goal or function of second-order science lies in its high potential for innovations and inventions which must be fully utilized in the future.

But novelty and innovation *per se* remain a rather weak defense for second-order explorations. Briefly put, second-order studies are able to fulfill, aside from their high relevance as innovation engines, two vital functions for the sustainability of the science system as a whole.

- The second basic goal or function of second-order science lies in its capability of achieving results of higher degrees of robustness, compared to their first-order counterparts. Meta-analyses which in the new terminology become second-order analyses point to the possibility of disconfirming or confirming first-order results and of achieving, thus, higher levels of robustness (see, for example, Borenstein *et al.* 2009; Hunter & Schmidt 2004; Kulinskaya, Morgenthaler & Staudte 2009).
- The third basic goal or function lies in the integration of first-order elements. Like in the instances of theories of theories, models of models, generative mechanisms of generative mechanisms or methodologies of methodologies second-order investigations initiate a deep search to more general or fundamental forms of theories, models, generative mechanisms or methodologies.

All three goals and functions, namely higher levels of novelty and innovations, higher levels of robustness and, finally, wider integration as well as higher generality, become vital for the evolution of first-order science. As first-order science advances, second-order science provides with its three vital functions for first-order science the sustainability of the overall science system.

3 A SKETCH OF A GRAMMAR OF NOVELTY

Over the last years a general grammar of novelty (see, e.g., Müller, 2013a) was developed in close analogy to cognitive grammars which are organized as systems of linguistic elements or building blocks, schemes or templates and cognitive-linguistic production rules which distribute these linguistic elements to the available templates[5].

For a grammar of novelty building blocks are not restricted to linguistic elements alone, but can and must be extended to technological or machine components, geometric forms, musical notations, elementary dance movements, objects like flags which can be recombined and transformed into new ensembles. Schemes or templates for a grammar of novelty comprise instances like induction, analytics, i.e., the decomposition into few elements, black-box (input-output relations), analogy formation and the like.

Production rules for a grammar of novelty can be specified with a small set of recombination operators which are used in the different stages and levels of innovation processes. These recombination operators change an initial ensemble into an innovation or invention as the final outcome:

Initial Configuration $\rightarrow$ [Transformation] $\rightarrow$ [Recombination] Operators]] Innovative Outcome

These recombination operators, in combination with a small number of schemes or templates are capable of transforming available elements or building blocks from an initial configuration in elementary or composite ways into its innovative final stage.

Table 1 presents a list of 24 recombination operations which, however, should not be regarded as exhaustive or complete, but as a useful starting point for a specification of different recombination operations.

[5] On these cognitive grammars, see especially Langacker, 2008 und 2009 und zur kognitiven Linguistik Croft & Cruse, 2004, Geeraerts, 2006 oder Geeraerts & Cuyckens, 2007.

In general, an innovative research process like the building of a new and general methodology or the construction of an integrative framework can be described as a very long sequence of recombination operations at different levels from the lowest micro-level of letters, words or sentences up to the highest macro-level of general themes which constitute the final organization of the present article.

Table 1 Primary, Elementary and Composite Recombination Operations

Primary Operations	Description of Operation
➢ PO_1	*Marking*, the differentiation of an empty space into an marked and into an unmarked space
➢ PO_2	*Unmarking*, the deletion of a marked space
Elementary Operations	**Description of Operation**
➢ EO_1	*Duplicating*, the copying or re-production of a given building block [A → AA]
➢ EO_2	*Binding*, establishing a relation between two building blocks [A, B → AB_R]EO_2
➢ EO_3	*Dissolving*, the elimination of a relation between two building blocks [AB_R → A,B]
➢ EO_4	*Adding*, appending a new building block to a given one [A → AB]
➢ EO_5	*Deleting*, the removal of a specific building block from a given unit [AB → A]
➢ EO_6	*Including*, the inclusion of an autonomous building block into a new hierarchical ensemble [A, B → A[B]]
➢ EO_7	*Separating*, the separation of a hierarchical ensemble into two autonomous units [A[B] →A,B]
➢ EO_8	*Re-entry*, the application of a building block A onto itself [A → A(A)]
➢ EO_9	*Horizontal Moving*, the horizontal movement from one building block to another one [A → B or B → A] or from a domain of building blocks D_i to another domain D_j
➢ EO_{10}	*Vertical Moving*, the vertical movement from a building block at $level_i$ to a building block at $levels_{(i+1)(i-1)}$ or from a level L_i to a level L_j
Composite Operations	**Description of Operation**
➢ CO_1	*Ordering*, re-arranging a group of building blocks to a new order: [(CDEBA) → (ABC DE)]
➢ CO_2	*Randomizing*, the re-arrangement of a group of building blocks in a random order: [(ABCDE) → (DABEC)])
➢ CO_3	*Integrating*, the blending of two or more building blocks into a single element [A, B, … → C]
➢ CO_4	*Breaking*, the separation of a single building block into two or more separate building blocks [C → D, E, …]
➢ CO_5	*Deepening*, the specification of a new ensemble (NM ….) at a lower level L_{j-k} which is able to account for the operations of given unit with elements (AB …) at level L_j: [(NM… ↑ (AB ..C)]
➢ CO_6	*Heightening*, the specification of a new ensemble (UV …) at a higher level L_{j-k} which is able to account for the operations of a given unit (AB…) at level L_j: [(UV …) ↓ (AB …)]
➢ CO_7	*Widening*, the augmentation of a given ensemble or domain with building blocks from other domains or levels (AB → ABCFKR...)
➢ CO_8	*Shortening*, the reduction of a given ensemble (ABCD ... → AB)
➢ CO_9	*Selecting*, the selection of at least one building block from various ensembles: [(ABCD)(EFGH)……(WXYZ)] → E
➢ CO_{10}	*Inverting*, the opposite sequence of building blocks (ABC → CBA), of center (C)—periphery (P) positions, C(A) & P(B) → C(B) & P(A), etc.
➢ CO_{11}	*Swapping*, the exchange between at least two building blocks within two or more ensembles [(AB…)(CD…) → (AC…)(BD…)]
➢ CO_{12}	*Crossing-Over*, the crossing of at least two ensembles and their merging into a new configuration [(ABCD)(EFGH) → (ABGH)(EFCD)]

For the emergence of novelty or innovation the scheme or template of analogy formation plays a crucial role which puts heavy emphasis on analogical transfers or horizontal or vertical movements between different scientific domains (Coenen, 2002, Fauconnier & Turner, 2003, Hollingsworth & Müller, 2008, Johnson & Lakoff, 2011, Maasen & Weingart, 2000).

From a constructivist perspective this scheme of analogy formations AF is based on the following set of rules. [6]

The first step lies in the identification of a reference domain R which becomes conceptualized in a structural description DR^{ST} which is focused on a reduced set of relations and features which seem useful for the purpose of analogy building. The next step lies in a horizontal or vertical movement of the structural description to one or more target domains T for which the structural description becomes then DT^{ST}. The third step lies in the replacement of the elements form the reference domain and

[6] This article does not use the word metaphor, but analogy formation instead. The main reason for this procedure is due to the fact that metaphors are considered as a subset of analogy formation: „Not all analogies produce a metaphor, but each metaphor presupposes an analogy (translated by KHM).“ (Coennen, 2002:97)

their substitution with a suitable conceptual apparatus from the target domain T. An analogy formation turns out to be successful if the new descriptions DT^{ST} or DT provide new and surprising insights into the target area.

It should be added that the grammar of novelty is based on such an analogy formation, too, from a structural description D^{ST} in the reference domain R of cognitive linguistic grammars G_L $DR^{ST}(G_L)$ and its new form of a structural description of a grammar of novelty G_N in the target domain T of innovations, inventions and the like: $DT^{ST}(G_N)$. Thus the analogy formation, symbolized as ≈ with respect to a grammar of novelty can be summarized as:

$$AF: DR^{ST}(G_L) \approx DZ^{ST}(G_N)$$

In the next section I will use the list of recombination operations to develop a rule-system which can be characterized as a general methodology for second-order science.

4 AN OUTLINE OF A GENERAL METHODOLOGY FOR SECOND-ORDER SCIENCE

For a general methodology for second-order science a few general guidelines are needed which can be classified as crucial and necessary for the entire range of second-order studies. According to the list of recombination operations in Table 1 a variety of ways are available and open. While recombination operations like duplicating, inverting or swapping appear even at second glance not suitable for relevant methodological guidelines, other recombination operators like widening, heightening or integrating seem highly suited for this purpose.

3.1 First Step: Selecting a Common Theme

The initial move in a second-order analysis lies in the specification of a common or a target first-order theme which lies in the center of the subsequent explorations.. With the help of a selection operation a huge variety of possible themes can and must be reduced to a single issue or problem which forms the common basis for subsequent second-order investigations. In this article I will use two examples, one from an output analysis of social science researchers worldwide who produced articles on the basis of the data sets from the European Social Survey (ESS), and one from a theoretical concept in sociology, namely the notion of standards of living for which a large number of different specifications can be found in the sociology literature.
Basically, the common theme must fulfill two requirements, namely, on the one hand, a large number of first-order analyses and, on the other hand, a cognitive status of what Jürgen Habermas phrased, a *neue Unübersichtlichkeit*. Both requirements are fully met by the two themes. The number of ESS-analyses lies already around 3000 at the current time. And living standards have been introduced to social research since the 1930s at the latest, starting with Otto Neurath (1931, 1937) and followed by authors like Weisser (1957) or Amann (1983) in a large number of different ways.

3.2 Second Step: Re-entry Operation

The next step produces a re-entry in the common theme and its transformation to a second-order topic. Figure 3 presents the transformation from a first-order theme X to a second-order issue through a re-entry operator RE.

Figure 3 Operations with Re-Entries (RE)

Turning to the two examples, a re-entry-operation produces an ESS-based analysis of ESS-analyses as the common second-order theme for investigation. Likewise, second-order standards of living of first-order living standards become the new second-order issue for the subsequent analysis.

3.3 Third Step: Adding the Goals of Analysis

The next step requires an explicit formulation of goals of the participant researchers, regardless whether the underlying epistemology and research design follows an observer-inclusive or observer-exclusive trajectory. The goals of analysis have to specify the objectives which a second-order analysis has to reach.

In the case of the ESS-study on ESS-studies the main goals lies in the construction of three different profiles.

- The first goal lies in the creation of a comprehensive profile of ESS-utilizations. Here, an overview must be reached on highly used ESS-domains or variables and, conversely, on rarely used ESS-areas and variable groups or on the number of ESS-rounds which formed the basis for the ESS-analysis.
- The second goal can be summarized as the building up of a profile of ESS-users. With respect to the second target, a comprehensive summary must be reached on the regional affiliation of authors, their distribution across different disciplines or on their thematic preferences and on the hot topics for the scientific ESS-community.
- Finally, the third goal is aimed at the specification of a profile of ESS-publications. With respect to the third goal a general scheme must become available which shows the main types of ESS-publications or the languages of ESS-publications.

With respect to the second-order study on living standards the primary goal lies in the construction of a more comprehensive and integrative framework for living standards which is able to include the available diversity of approaches into single schemes.

3.4 Fourth Step: Widening with First-Order Building Blocks

The fourth step lies in building a sufficiently large set with first-order elements on the common second-order topic like articles, research reports, books, tests, correlations, models, theories or other first-order components. Within the fourth step the second-order theme has to be widened in order to establish a rich first-order basis of relevant building blocks for subsequent second-order explorations.

With respect to the second-order ESS-study, an intensive search was undertaken which looks for publications in journals, books, research reports, conference proceedings and the like which use the data bases of the ESS as their major source for empirical analysis. In this context Google Scholar provides a useful search instrument which offers usually a rather comprehensive overview of relevant publications. In the end, approximately 3000 articles were found which became the first-order base for further second-order investigations.

In the case of living standards one needs to assemble different specifications from, to mention only several relevant German and Austrian contributions in the 20th century in alphabetical order, Anton Amann (1983), Gertrud Backes (1997), Gerhard Bäcker *et. al.* (1980/2008), Stefan Hradil (1983, 1987, 1990), Ingeborg Nahnsen (1992), Otto Neurath (1931, 1937), Gerhard Weisser (1957, 1978) plus more recent versions which emphasize, for example, gender-specific aspects (see, e.g., Hammer & Lutz, 2002). These different specifications of systems of standards of living can be summarized in different ways, using the terminology of the respective authors. In terms of comparability, a useful way of creating a preliminary overview could be, for example, a focus on uniqueness which selects and specifies only those elements which can be found in a single specification scheme, but not in the other ones.

3.5 Fifth Step: Ordering First-Order Building Blocks

The next step is rather obvious because what is needed at this point is an ordering of the various building blocks according to a small set of order parameters. These order-parameters re-arrange the first-order building blocks and place them in comprehensive schemes or data-bases. The specification of these order-parameters is highly dependent on the second-order issue, the available first-order building blocks and the goals of analysis. The two examples used as instances for second-order analyses require significantly different order parameters and exhibit, thus, the context specificity of an appropriate choice of these order-parameters.

In the case of the second-order ESS-analysis the following order-parameters or criteria were chosen which provide basic information on the scope and the organization of a first-order analysis with ESS-data.

- Type of publication: The first order parameter distinguishes between various types of publication like a journal article, a book or a book chapter, a conference paper, a research report and the like.
- Relevant discipline(s) for journal publications: In case of journal publications the academic disciplines most relevant for a journal are to be documented.
- Language of publication
- Country affiliation of first listed author
- Number of authors
- Main ESS-domain(s): The ESS-survey is divided into several larger segments like politics, citizenship, government, immigration and nationality, inequality and the like which are documented for each publication.
- Specific Topics and ESS-variables: Each of the main ESS-domains is separated into a small number of indicators or variables and this order parameter determines the specific ESS-variables used in a publication.
- ESS-rounds used for the analysis: The ESS is organized in two year intervals and this criterion specifies whether an ESS-analysis focuses on a single round, on two or on more rounds or on all rounds so far.
- Keywords: Here the keywords listed in a publication are reproduced and each article is documented with keywords from the side of the second-order investigator.
- Methods of data analysis: This order parameter specifies the type of data analysis, ranging from basic statistics to more advanced methods like cluster or factor analysis up to multi-level modeling.
- Intensity of data usage: This order parameter differentiates between varying degrees of dependence on ESS-data, ranging from an exclusive reliance of ESS-data to only a marginal usage of ESS-data, compared to other data sources.
- Other European data sources: Finally, the last criterion refers to other European data source like the International Social Science Program (ISSP), the European Value Survey (EVS) or the World Value Survey (WVS) and specifies the inclusion of these other data sets in a given publication.

With these parameters the available first-order ESS-articles can be re-arranged in a large data base which is to become the focus for subsequent steps.

Turning to the second-order study of living standards the order parameters can be specified in the following way. Here, the criteria used require a conceptual and content analysis and a mostly qualitative coding routine, compared to the largely quantitative encodings in the case of ESS-studies.

- Goals of the different approaches to standards of living: An overview of a single or multiple goals for the construction of the various systems of standards of living
- Theoretical background assumptions
- Relevant domains for standards of living: Listing all relevant major domains for living conditions in each of the schemes for living standards
- Indicators for each domain
- Available data bases
- Methods of analysis
- Main results of empirical analyses: A summary of empirical results on empirical distributions or more theoretical relations and functions between single indicators or entire fields.

As can be seen from these two examples of second-order analysis they are specified in very different ways, even though they share the same academic discipline and even the same sub-discipline, namely empirical social research.

3.6 Sixth Step: Integrating, Deepening, Heightening, etc.

The sixth step in the general methodology of second-order science stresses the need to find new solutions which are capable of entailing all major building blocks from the set of first-order

contributions. The sixth step is, once again, very much dependent on the goals, on the type of first-order building blocks and on the available basis as a result of the ordering operation. Four examples should help to clarify this point.

- With respect to a theoretical concept the sixth step performs a conceptual analysis in which the various first-order building blocks become integrated or included.
- In terms of generative mechanisms or models one needs to specify more general or basic mechanisms or models which are able to account and to tame the complexity of the available first-order approaches.
- For areas like tests, results of statistical analyses or data bases like in the case of the second-order ESS-analysis mainly advanced statistical analyses are needed for which a large quantity of methods and procedures are already available under the umbrella term of meta-analyses.
- Finally, a scientific field or an academic discipline requires mainly conceptual work in order to present an outline of a cybernetics of cybernetics (Mead, 1968), a logic of logic or a management science of management science. In this case, the sixth step produces a sketch for the main organization and tasks of a new second-order field, a discipline or a hybrid compound of disciplines.

In terms of recombination operators these different tasks can be achieved either by deepening and heightening, i.e., by a deeper or higher level of analysis, via integrating, i.e., by an integrative step which recombines the available variety into a new form of cognitive organization, by including, i.e., by the inclusion of one or several first-order building blocks in a

With respect to the second-order ESS-analysis the major work lies in an in-depth analysis of the rich data base and in statistical analyses of this data base. Here, the three different empirical profiles for ESS-utilization, for users and for publications must be generated according to the three primary goals of analysis.
The case of the second-order analysis of living standards must develop one or more integrative schemes which are able to account for the diversity of first order specifications. Here, an interesting way of integration lies in the specification of a robust and general new terminology with evolutionary stable concepts which can be used for practically all forms of human societies, past, present and, most probably, future.[7] In a recent publication an evolutionary stable terminology was created in terms of a RSO-scheme with three major components for an integrative system of standards of living, namely resources R, settings S and cognitive-emotional organization O (Müller, 2013b).

3.7 Seventh Step: Transfers and Effects for First-Order Science

The next step adds an important element especially for the relations between second- and first-order science. In this part of analysis the transfer elements of second-order investigations and their effects and impact on first-order research are to be discussed in greater detail. In general, a large number of outputs of second-order studies can be used by the respective fields of first-order science for new explorations. In the simplest instances, second-order studies question the effects of medical drugs, based on a large number of first-order clinical studies or the validity and reliability of psychological tests, again on the basis of a large quantity of first-order test procedures. In more sophisticated cases like the example of the ESS-study a second-order investigation produces new empirical insights which can be used by a variety of researchers across different fields, as will be shown immediately. More complex second-order outcomes in theory or model formations lead to further first-order explorations in new areas of applications or to new rounds of tests.
Turning to the example of a second-order analysis of ESS-articles one can point out to a large number of effects not only for future ESS-data collection processes and for ESS-based research, but for different groups outside the domain of social comparative research as well.

- First, the ESS-coordinating team receives a new and highly valuable utilization profile of ESS-data sets which becomes relevant for subsequent rounds of ESS-surveys.
- Second, social researchers become familiar with the main thematic interests of their community. Moreover, the weakly analyzed parts of ESS-data offer the possibility to initiate new ESS-analyses. Furthermore, the range of available themes can be used for recombinations and for the creation of new ESS-topics which then become the focus of analysis.
- Third, experts in the field of methods for social research get an overview of blind spots in terms of available methods of analysis. For example, a marginal number of articles can be found which use the entire spectrum of all available ESS-data from the six rounds so far. This provides a strong incentive to develop new dynamic tools of analysis which are specially constructed for a complete utilization of the ESS-data base across all rounds.
- Fourth, specialists in the sociology of science gain empirical data on the regional distribution of social research and on the thematic preferences of social researchers across time.
- Fifth, as the ESS-data production continues in its two years intervals sociologists of knowledge will be able to work with a rich data-base on shifts in thematic interests of European social researchers and relate these shifts to societal challenges and changes, economic and financial crises or political debates in the public domain.
- Sixth, researchers in the area of embedded cognition are offered a diversified and growing data source on the interpretation of data by ESS-researchers and can use these findings for laboratory studies of interactions between survey interviewers and respondents.

Due to the variety of transfers within and outside the domain of social research the example with a second-order ESS-analysis becomes a fascinating instance that second-order analysis in a seemingly narrow domain can generate results for a much wider number of first-order fields.

The final products of a second-order investigation on living standards offer more integrative frameworks for future research on living standards which can be used for new exploratory studies with new questionnaires, additional methods and

[7] On the requirements for evolutionary stable concepts, see Haag & Müller, 1992.

expanded data bases. Additionally, the new integrative second-order frameworks with their evolutionary conceptualizations can be analyzed in terms of relations, correlations and explanatory relevance. Moreover, these new integrative frameworks for standards of living enable a clearer view on existing data gaps or thematic blind spots. Finally, the new second-order frameworks can be used to re-arrange different systems of living standards across time and allow, thus, a dynamic comparative analysis.

3.8 Eighth Step: Second-Order Science ↔ Society/Environment-Relations and Dynamics

The last step in the general methodology does not belong to the core group of necessary steps, but can be added as an option. This additional step requires at least a small analysis of a particular second-order study and its outcomes on the one hand and the potential effects and consequences of this specific piece of research on the wider environment across science and society in general. Such a step might be superfluous in many instances, but could be useful especially in the case of a long-term analysis or in instances with a high political or great societal relevance.

For the two social science examples no such impact-study need to be produced because these investigations are primarily directed to relatively small segments of research groups, so the repercussions for the wider societal environments will turn out as marginal or negligible.

Nevertheless, these eight steps comprise, in essence, the basic specifications for a fully developed general second-order methodology across all scientific areas from logic and mathematics to the natural or to the social sciences.

5 A SKETCH TOWARDS A GENERAL METHODOLOGY OF SECOND-ORDER SCIENCE

The journey to the land of second-order science and its general methodology is almost finished. Recapitulating the steps in the previous analysis and generalizing them one arrives at a general methodology for second-order science studies which includes the subsequent steps for any particular building block X from first-order science like a concept, relation, theory, model, test, generative mechanism, scientific field, etc. which are summarized in Table 2.

On the left side of Table 2 one finds the necessary or optional steps for a general methodology of second-order science in terms of basic recombination operators, the second column presents a short description of these specific recombination operations.

Table 2 Core Steps for a General Methodology of Second-Order Science

Recombination Requirements Operations	Description of Specification
Selecting X	Consensus on a common first-order theme X
Re-entry X	A re-entry operation in the first-order theme and the creation of a corresponding second-order topic
Adding Goals[X]	Consensus on the goals of the observer(s)
Widening X[First-Order Building Blocks]	The compilation of a large number of first-order building blocks on the common theme
Ordering X[First-Order Building Blocks]	Applying various methods for a re-arrangement of first-order building blocks like data-bases, new conceptual schemes, etc.
X(X): {Integrating, Deepening, etc. [First-Order Building Blocks]}	The core part of second-order analysis which, in dependence from the goal set, integrates, heightens, deepens first-order building blocks and which produces a final output.
Adding [Impact X(X) → X[First-Order Science]	Generating building blocks for first-order science and assessing the effects of the final second-order outcomes for first-order research on the common theme X.
Adding [X(X) ↔-Society/ Environment-Relations & Dynamics (optional)]	An evaluation of the relations between the outputs of second-order research on X(X) or of X and the wider environment across science and society and their dynamic patterns

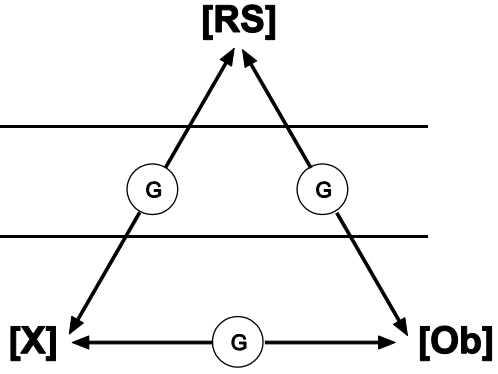
The first seven steps can be classified as necessary whereas the eighth step is considered as optional because this particular step does not change the content of X(X) but focuses at the wider relations and effects of X(X) for science and society.

These eight steps can be viewed as a sketch of a general methodology for second-order science which must be supplemented with a very broad range of special methodologies for specific disciplines as well as second-order methods for different purposes and goals.

6 THREE TYPES OF REFLEXIVITY IN SCIENCE

Finally, the new architecture of second-order science and its general methodology lead to a new configuration of reflexivity in science which distinguishes between different types of reflexivity.

Figure 4 A Triadic Configuration between an Observer Ob, a Domain of Investigation X and the wider Research and Societal Environments RS



The starting point lies in a triadic configuration between an observer Ob, her or his domain of investigation X and, finally, her or his wider research and societal environments RS where these three components Ob, X and RS generate each other (see also Figure 1.2)

In such an ensemble, reflexivity can be accomplished in three separate and strictly independent ways with respect to each of the three elements Ob, X and RS.

- Reflexivity with respect to the domain of investigation (scientific reflexivity): The first type becomes reflexive through a re-entry operation X(X) in the domain of investigation X where re-entry operations are produced with building blocks from first-order science.
- Reflexivity with respect to the observer (self-reflexivity): The second-type of reflexivity is focused on the observer Ob and includes an observer in her or his research designs and her or his scientific operations. Due to the focus on observers one can also classify the second type as self-reflexivity. The differences between observer-exclusive and observer-inclusive is beautifully summarized by the following quote from Eric Kendel who describes an observer-exclusive procedure in the following manner:

  > Scientists make models of elementary features of the world that can be tested and reformulated. These tests rely on removing the subjective biases of the observer and relying on objective measurements and evaluations. (Kendel, 2012:449)

  Observer-inclusive or self-reflexive designs and procedures can be characterized by an inversion of Eric Kendel's quote above in the following way.

  > Scientists make models of elementary features of the world that can be tested and reformulated. These tests rely on removing the objective biases of observer-free tests and relying on observer-dependent measurements and evaluations.

- Reflexivity with respect to the wider scientific and societal environment (environmental reflexivity): The third type is not based on a special re-entry operation, but simply completes the three possible sources of reflexivity. The third type focuses on the relations between elements of first- or second-order science and the wider environment RS, both within science and across science.

Aside from these three basic types of reflexivity an important point lies in the possibility of combining these three types to more complex configurations and research designs. In principle, two additional roads are open, aside from the low road of a single type. The terms of a low, middle and a high road are not used as a quality predicate, but stand for different complexity levels of research designs and research processes.

- The middle road to reflexivity: Here, two of the three reflexivity types become recombined, either by re-entering in first-order building blocks and by a re-entry in observer operations, by re-entering in first-order building blocks and adding the wider research and society relations or, finally, by a re-entry in the observer operations and by adding the observer – environment relations. All three instances are characterized by more complex research designs and production processes, compared to the three single types.
- The high road to reflexivity: In this instance a re-combination of all three reflexivity types is undertaken by a self-reflexive or observer-inclusive second-order analysis which also adds a non-trivial investigation of the eighth step in the general methodology on the relations between X(X) and the wider research and society environment RS. This recombination becomes the most demanding and most complex one and usually requires time and resources which are currently unavailable in conventional research processes.

The differentiation into three independent forms of reflexivity and their potential recombinations should become useful as a guideline for organizing higher forms of reflexivity in scientific research processes.

7 CONCLUSIONS

With the three types of reflexivity this article comes to a logical end. It might be interesting to note that this article itself, apart from this paragraph, does not contain any major reflexive elements at all because it did not deal with the typical second-order configuration of X(X), the I of the observer was mostly excluded and no environmental relations between X(X) and research and society were discussed. Thus, this article itself must be qualified as a proto-analysis, as a pre-study and as a sketch towards a general methodology of second-order science which became also the title of the paper.

Condensating its entire content into a single drop of aphorism one can summarize second-order science and its general methodology in the following way.

- First-order science: The science of exploring the world
- Second-order science: The science of reflecting on these explorations

In the long run one will most probably see the co-evolution between first-order and second-order science where first-order science continues to explore nature and society and where second-order science provides the necessary components of innovation outlets, quality control and the drifts towards more generality, integration or depth.

Bibliography

[1] A. Amann, **Lebenslage und Sozialarbeit. Elemente zu einer Soziologie von Hilfe und Kontrolle.** Berlin:Duncker&Humblot, 1983.

[2] G. Bäcker, G. Naegele, R. Bispinck, K. Hofemann, J. Neubauer, **Sozialpolitik und soziale Lage in Deutschland. Gesundheit, Familie, Alter und soziale Dienste** (Band 1), vierte Auflage. Wiesbaden: Verlag für Sozialwissenschaften, 2008.

[3] G. Backes, „Lebenslage als soziologisches Konzept zur Sozialstrukturanalyse", **Zeitschrift für Sozialreform**, Vol. 43, No. 9, 704 -727, 1997.

[4] M. Borenstein, L.V. Hedges, J.P.T. Higgins, H.R. Rothstein, **Introduction to Meta-Analysis.** WileyBlackwell, Chichester, 2009.
[5] H.G. Coenen, **Analogie und Metapher. Grundlegung einer Theorie der bildlichen Rede**. Berlin:de Gruyter, 2002.
[6] W. Croft, A.D. Cruse, *Cognitive Linguistics*. Cambridge:Cambridge University Press, 2004.
[7] G. Fauconnier, M.Turner, **The Way We Think: Conceptual Blending and the Mind's Hidden Complexities.** New York:Basic Books, 2003.
[8] D. Geeraerts (ed.), **Cognitive Linguistics. Basic Readings.** Berlin:Walter de Gruyter, 2006.
[9] D. Geeraerts, H. Cuyckens (eds.), **The Oxford Handbook of Cognitive Linguistics.** New York:Oxford University Press, 2007.
[10] G. Haag, K.H. Müller, K.H, "Employment and Education as Non-Linear Network Populations, Part I: Theory, Categorization and Methodology", G. Haag, U. Mueller, K.G. Troitzsch, (eds.), **Economic Evolution and Demographic Change. Formal Models in Social Sciences.** Heidelberg:Springer-Verlag, 349 – 376, 1992.
[11] V. Hammer, R. Lutz (eds.), **Weibliche Lebenslagen und soziale Benachteiligung. Theoretische Ansätze und empirische Beispiele.** Frankfurt:Campus, 2002.
[12] S. Hradil, „Die Ungleichheit der ‚Sozialen Lage'. Eine Alternative zu schichtungssoziologischen Modellen sozialer Ungleichheit", Kreckel, R. (ed.), **Soziale Ungleichheiten**. Göttingen:Schwartz, 102 – 118, 1983.
[13] S. Hradil, **Sozialstrukturanalyse in einer fortgeschrittenen Gesellschaft. Von Klassen und Schichten zu Lagen und Milieus.** Opladen:Leske+Budrich, 1987.
[14] S. Hradil, „Lebenslagenanalysen in der Bundesrepublik Deutschland", H. Timmermann, H. (ed.), **Lebenslagen: Sozialindikatorenforschung in beiden Teilen Deutschlands**. Saarbrücken-Scheidt:Dadder, 125 -146, 1990.
[15] R.J. Hollingsworth, K.H. Müller, „Transforming Socio-Economics with a New Epistemology", **Socio-Economic Review** No. 3 (Vol.6), 395 – 426, 2008.
[16] J.E. Hunter, F.L. Schmidt, **Methods of Meta-Analysis: Correcting Error and Bias in Research Findings**, second edition. Sage Publications, Newbury Park, 2004.
[17] M. Johnson, G. Lakoff, **Leben in Metaphern: Konstruktion und Gebrauch von Sprachbildern**. Heidelberg:Carl Auer Verlag, 2011.
[18] L.H. Kauffman, „Self-Reference and Recursive Forms", in: **Journal of Social and Biological Structures** Vol. 10, 53 – 72, 1987.
[19] L.H. Kauffman, „Eigen-forms", Special Issue "Heinz von Foerster in memoriam" ***Kybernetes*** Vol. 34, 129–150, 2005.
[20] E.R. Kendel, **The Age of Insight. The Quest to Understand the Unconscious in Art, Mind, and Brain, from Vienna 1900 to the Present.** New York:Random House, 2012.
[21] E. Kulinskaya, S. Morgenthaler, R.G. Staudte, **Analysis: A Guide to Calibrating and Combining Statistical Evidence.** Wiley-Blackwell, Chichester, 2009.
[22] R.W. Langacker, **Cognitive Grammar. A Basic Introduction.** New York:Oxford University Press, 2008.
[23] R.W. Langacker, **Investigations in Cognitive Grammar.** Berlin:Mouton de Gruyter, 2009.
[24] S. Maasen, P. Weingart, *Metaphors and the Dynamics of Knowledge*. London:Routledge, 2000.
[25] M. Mead, "Cybernetics of Cybernetics", Foerster H. von *et al*. (eds.), **Purposive Systems**. Spartan Books, New York, 1–11, 1968.
[26] K.H. Müller, "Die Grammatik des Neuen", H.R. Fischer (ed.), **Wie kommt Neues in die Welt? Phantasie, Intuition und der Ursprung von Kreativität.** Göttingen:Velbrück Wissenschaft, 43 – 61, 2013a.
[27] K.H. Müller, „Lebenslagen, Ungleichheit und Lebensqualität aus radikal konstruktivistischer Perspektive", F. Kolland, K.H. Müller (eds.), **Alter und Gesellschaft im Umbruch. Festschrift für Anton Amann.** Wien:edition echoraum,, 219 -261, 2013b.
[28] K.H. Müller, *New Cybernetics. The Structure of a Scientific Revolution*. Wien:edition echoraum, 2014.
[29] K.H. Müller, A. Riegler, „Second-Order Science: A Vast and Largely Unexplored Science Domain", **Constructivist Foundations** (Special Issue 'Second-Order Science') No. 1, Vol. 10, 4 – 14, 2014.
[30] I. Nahnsen, „Lebenslagenvergleich. Ein Beitrag zur Vereinigungsproblematik", H.A. Henkel, U. Merle, (eds.), **‚Magdeburger Erklärung'. Neue Aufgaben der Wohnungswirtschaft. Beiträge zum deutschen Einigungsprozess.** Göttingen:Transfer Verlag, 101 – 144, 1992.
[31] O. Neurath, **Empirische Soziologie. Der wissenschaftliche Gehalt der Geschichte und Nationalökonomie.** Wien:Springer, 1931.
[32] O. Neurath, „Inventory of the Standard of Living", **Zeitschrift für Sozialforschung**, Vol. 6, 140 – 151, 1937.
[33] A. Riegler, K.H. Müller, K.H. (2014)(eds.), Special Issue of **Constructivist Foundations** on ‚Second-Order Science', No. 1, Vol. 10, 2014.
[34] G. Weisser, **Der europäische Mensch unter dem Einfluss der Industrialisierung.** Hannover: Niedersächsische Landeszentrale für Heimatdienst, 1957.
[35] G. Weisser, **Beiträge zur Gesellschaftspolitik: Philosophische Vorfragen, beratende Sozialwissenschaft, soziale Sicherung, Mitbestimmung, Verteilungs-und Vermögenspolitik, Ordnungspolitik, besonders Einzelwirtschaftspolitik.** Göttingen: Schwartz, 1978.

Cross-Cultural Communication Training for Students in Multidisciplinary Research Area of Biomedical Engineering

Shigehiro HASHIMOTO
Biomedical Engineering, Department of Mechanical Engineering, Kogakuin University,
Tokyo, 163-8677, Japan
shashimoto@cc.kogakuin.ac.jp http://www.mech.kogakuin.ac.jp/labs/bio/

ABSTRACT

"Biomedical Engineering" makes multidisciplinary research area, which includes biology, medicine, engineering and others. Communication training is important for students, who have a potential to develop "Biomedical Engineering". Communication is not easy in a multidisciplinary research area, because each area has its own background of thinking. Because each nation has its own background of culture, on the other hand, international communication is not easy, either. A cross-cultural student program has been designed for communication training in the multidisciplinary research area. Students from a variety of backgrounds of research area and culture have joined in the program: mechanical engineering, material science, environmental engineering, science of nursing, dentist, pharmacy, electronics, and so on. The program works well for communication training in the multidisciplinary research area of biomedical engineering. Foreign language and digital data give students chance to study several things: how to make communication precisely, how to quote previous data. The experience in the program helps students not only understand new idea in the laboratory visit, but also make a presentation in the international research conference. The program relates to author's several experiences: the student internship abroad, the cross-cultural student camp, multi PhD theses, various affiliations, and the creation of the interdisciplinary department.

Keywords: Communication Training, Multidisciplinary Research Area, Biomedical Engineering, Training for Students and Cross-cultural Program.

1. INTRODUCTION

Communication conveys information. Engineering is research field to be applied to the society. Preciseness is important for the communication in engineering to be applied to the society.

Communication is realized through various networks: face to face conversation, letters, drawings, telephones, electrical networks.

Misunderstanding often occurs in a multidisciplinary research area, because each area has its own background of thinking.

A common base is necessary for communication. Similar experiences develop the common base. When common rules are defined, the communication becomes easier. That is the reason why you learn language, mathematics, SI unit, etc.

The biomedical engineering field is multidisciplinary [1-9]. That includes various fields other than engineering: biology, medicine, and pharmacy. In the field, communication is important between fields: e.g., between engineering and medicine.

In an international project, you may experience misunderstandings, which depend not only on the language, but also on the cultural background. In a research project in the interdisciplinary field, you also experience misunderstandings, which depend on the methodological backgrounds. In this point of view, both international projects and interdisciplinary projects have the common problem. The problem supplies a good chance for communication training.

Digital technology gives us useful tools of copy. We can easily access to large amount of previous data through the internet. Student should learn the right way to use these tools.

In the present study, a cross-cultural student program has been designed for communication training in the multidisciplinary research area.

2. METHODS

Group Activity and Presentation Competition

The annual cross-cultural student program of Biomedical Engineering in Thailand has been started in 2011 [8, 9]. Students, who participate in the program, were divided into several groups. Each group has to make a report on a theme, and to make a presentation at the final session. Two days are available to make the report and to prepare for the presentation.

The theme of the case study was “Oil dispersed over the ocean by an accident of a tanker” last year.

Students are allowed to use the internet to check information. They can use a personal computer to make the report, and to make slides for the presentation.

Laboratory Visit

Several universities have special programs on biomedical engineering in the world. The author has communicated with several coordinators of the programs. Some of them supported to create the first department of biomedical engineering in Japan in 2006 [1-7]. Some of them agree to collaborate with our group. Some of them have welcomed our students, and have exchanged idea in the annual laboratory visit since 2008 [8, 9].

Presentation in International Research Conference
Students have attended the annual international multidisciplinary research conference, and have made oral presentations since 2004 [8, 9].

3. RESULTS

Group Activity and Presentation Competition
In 2013, fifteen students from Thailand (includes international students) and ten students from Japan joined in the seminar. Their backgrounds were mechanical engineering, material science, environmental engineering, nursing, dentist, pharmacy, and electronics. In each group students discussed on the issue, picked up agenda, and adjusted the process to make a final report of the group. Students exchanged idea in each group (Fig. 1).

One student designed a special machine to collect oil. Some students proposed a biological method to collect the oil. Another student proposed a chemical method to change the material. Some students evaluated an economical aspect to the proposal.

They were able to understand global information, translating English to their own native language at the internet. They easily found data on the internet (Fig. 2). They made slides with data, which are available on the web side.

Fig. 1: Group discussion.

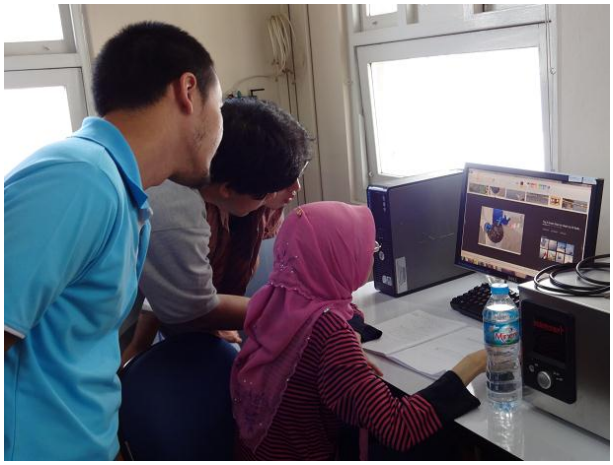


Fig. 2: Slide preparation with internet.

Several groups made presentation with slides (Fig. 3). In the slides, they used figures, which they found on the web. In one group, one member used the white board to write figures by himself (Fig. 4).

It was the first experience for Japanese students to join in a group activity in English. The evaluation to their English was not very good, but the presentation of every Japanese student was understandable to Thai students. The figures in the slides might help for Thai students to understand the outline of the presentation. The presentation is good training for the students to explain contents in the logical order.

The presentation also gave a Japanese student a good opportunity to express himself to the person at the first meeting. After the seminar, communication among students continued to the sightseeing in the traditional places. Some students have kept in touch with the participants by e-mail (Figs. 5 & 6).

Laboratory Visit
In 2013, ten students visited two universities in Thailand, and four students visited two universities in USA.

It was not easy for Japanese students to understand the lecture in English (Figs. 7-9).

Fig. 3: Presentation with slides.

Fig. 4: Presentation with writing on board.

Several research projects in biomedical engineering were introduced to Japanese students. The topic was familiar to Japanese students, because they knew the instruments. Students were able to exchange ideas about the experimental system.

Fig. 5: Cross-cultural student program (A).

Fig. 6: Cross-cultural student program (B).

Fig. 7: Laboratory visit (A).

Presentation in International Research Conference
Four students made each oral presentation last year (Fig. 10). The topics are as follows:

1) Behavior of Cells through Micro Slit
2) Effect of Mechanical Stimulation on Orientation of Cultured Cell
3) Micro Trap for Flowing Cell
4) Effect of Micro Ridges on Cell Culture
5) Observation of Biological Cells in Rhombus Parallelepiped Flow Channel
6) Finite Element Analysis of Bone Remodeling: Resident's Ridge Formation in Femoral Condyle

Several students made their own poster presentations in the international symposium last year (Fig. 11).

Fig. 8: Laboratory visit (B).

Fig. 9: Laboratory visit (C).

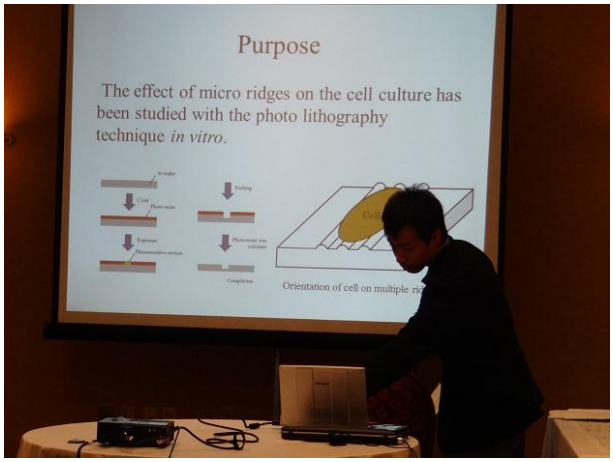


Fig. 10: Oral presentation in international conference.

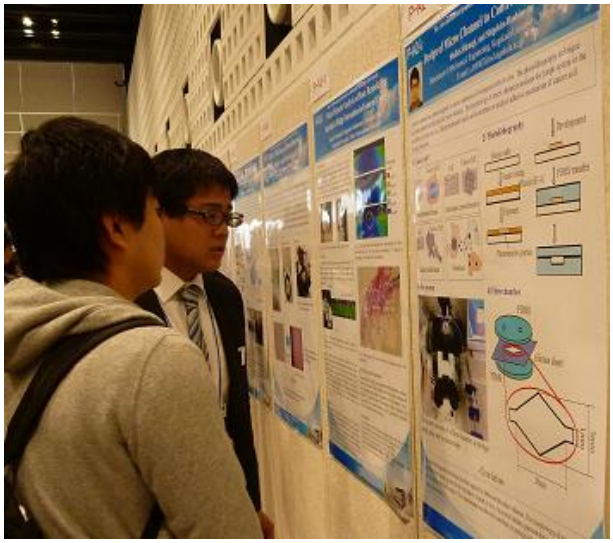


Fig. 11: Poster presentation in international conference.

4. DISCUSSION

Reproducibility
Reproducibility of a result is important in the Science field. The result should be repeatable in the same condition. The result is confirmed, when the same result is realized with the following trial. Science is not a magic. The condition should be disclosed to realize the same result by another trial.

In biology, on the other hand, it is not easy to confirm reproducibility, because the same condition is hardly controlled in biological events. In biological events, everything is variable, and never repeats the same situation.

References
Finding is new, and nobody knows before. It is always original.

Design is created by someone, so that design has a origin previously. Design should be related to references, even if it is created through revolution.

References help the design in several aspects. They identify the position of the design among previous things. They show relation to another thing. They confirm its value. They help idea to be realized.

Reference should be quoted as that was existed. It should not be modified at all. It should be the same as the original.

Reference should be listed with enough information for someone to seek for the origin. If the information has been edited several times, the number of edition should also be listed. Do not quote like the way as telephone game or ear-duster. You should quote the original reference. References are also effective for new findings, although you have to be careful for plagiarism.

Digital Data
Most of students confuse "copy and paste" and "plagiarism". What we should learn is how we should use the function of copy in digital culture.

Digitized data decrease ambiguity of analog data. Digital data can be easily not only copied, but also modified. Digital data include not only text, but also figures. The figure made of digital data can be easily modified: color, brightness, size, rotation, and so on (Figs. 12 & 13).

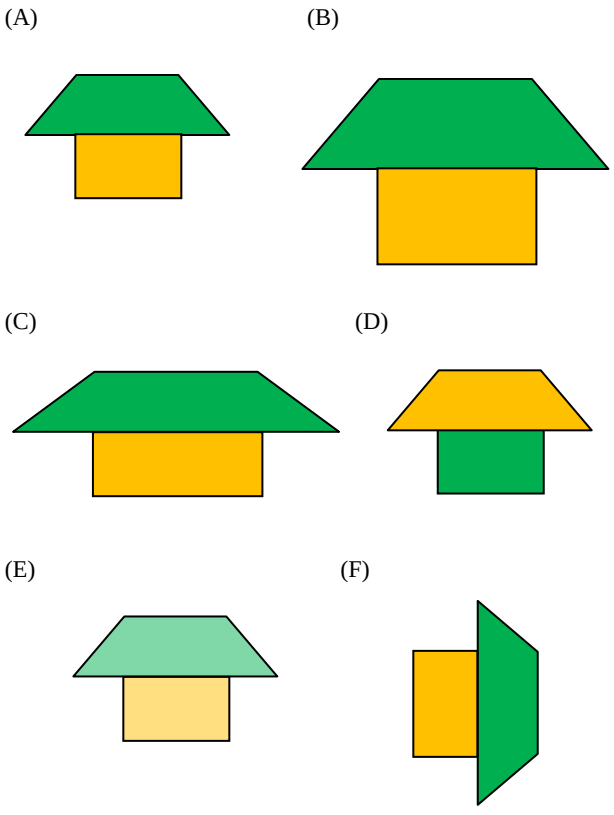


Fig. 12: Modification of digital data: original (A), bigger size (B), ratio change (C), color (D), brightness (E), rotation (F).

How should we use the function of copy in the digital culture. We should copy original data. Do not copy a copy. Do not give misunderstanding by modification. We should identify the source. Adding arrows and scale bars would be allowed.

Science is different from art. Although art should be original and creative, science should be universal. The method to transmit the information should be universal in science. If the information is described in the unique way, the information may not be understandable for another person.

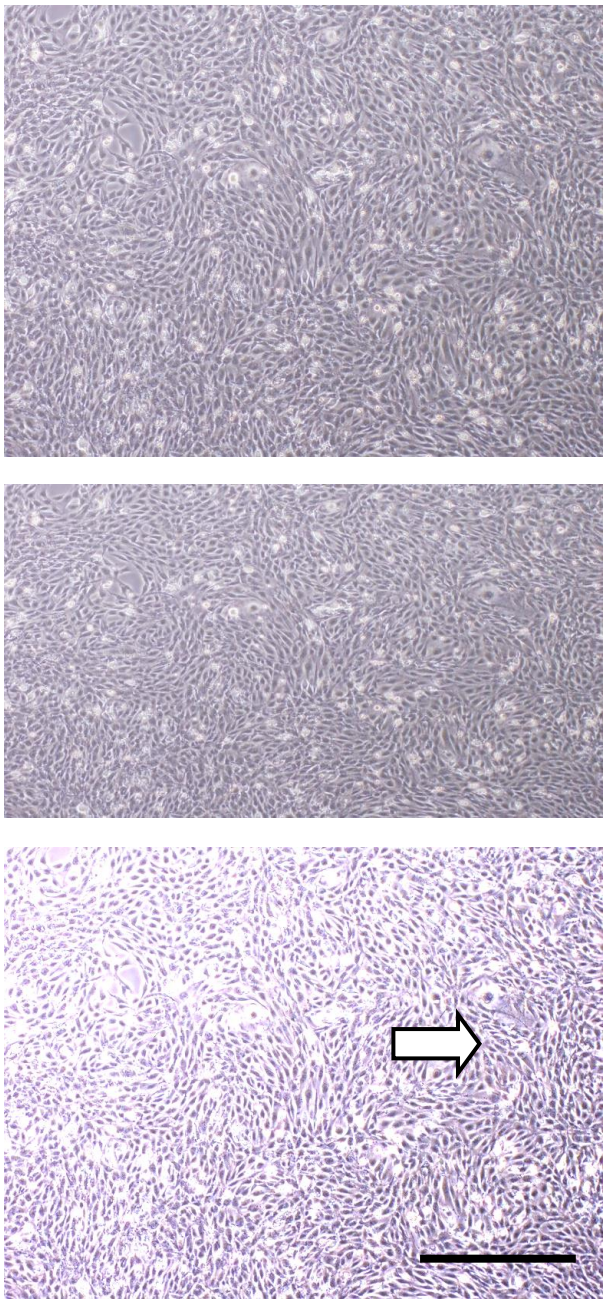


Fig. 13: Modification of digital data: original (A), ratio changed (B), contrast changed (C), additional arrow and scale bar (C).

The information should be available to everyone, and attribute to society. For universal communication, mathematics is useful. The universal unit system has been developed. Description should be logical.

International Language

In one's own native language, communication is easier. A large amount of vocabulary can be used. In the native language, people feels nuance. The same background allows using abbreviations. The abbreviation is not good for preciseness of communication. Be careful at using symbols, which have different meaning according to its background.

It is not easy for foreigner to create original sentence in English. It is, on the other hand, good training for logical expression.

Grammatical check is not enough. Preciseness is necessary. Nuance is not necessary in the logical writing. Technical term takes an important role. Each field has a rule for expression. Author has better to follow the rule. Author may copy the expression in the same special field of study.

The note of experiment is important: it is precise record of protocol for oneself to memory for the next experiment.

Recently, we have a lot of tools for communication. Although the e-mail system is very convenient for communication, communication on face to face has more information than digital signals: movement, atmosphere, and many expressions. Letters can reveal feeling by handwriting. A telephone can give a tone of the voice. A handshake tells temperature, and the force of the muscle.

Paying attention to the background is important for communication training. You may be surprised if some language systems do not have a term, which means "Reflection". The culture might be positive.

At the beginning of the seminar, students tend to pay attention to the language itself. After the seminar, students found: "it is easy to find the rule, but difficult to understand the background".

Multidisciplinary Field

"Biomedical Engineering" is a multidisciplinary field of study, which relates to engineering and medicine [2].

When I was a student, I experienced a technical internship in the institute of the artificial heart in Free University Berlin. The research project of the artificial heart had been supported by collaboration between engineering and medicine. The experience gave me international sense and interdisciplinary sense, simultaneously.

I myself joined the cross-cultural student camp every year, since I was nineteen years old. I experienced a lot of difficulties to communicate with students of different field of study, and of different background of culture.

I found different disciplines, when I took examinations for multiple PhD theses: one for medicine and the other for engineering. The research in the field of biology is based on individuality and time dependent, so that statistical processing is indispensable. The research in the field of engineering, on the other hand, is based on homogenization, so that the

experimental condition should be controlled. The referee of medicine requested number of experiment with keeping the protocol, although the referee of engineering requested the sophisticated condition of the experiment.

I also found different disciplines, when my affiliation changed: school of medicine, electronics, biomedical engineering and mechanical engineering. Each special field of study develops own discipline including the style of education. Each discipline has one's own technical terms. For example, "control" means "comparison" in medicine and "regulation" in engineering, respectively.

Kogakuin University has been founded by Hiromoto Watanabe in 1887. He tried to make networks for interdisciplinary education.

Creating the first department of "Biomedical Engineering (including bachelor, master, and PhD courses)" in Japan was a big challenge (Fig. 11). I created a new concept for the interdisciplinary department [1-7].

The multidisciplinary field makes students learn several things: logical thinking, and flexibility without prejudice. The common background of "Biomedical Engineering" helps them find a way of thinking.

The shocking experience of the cross cultural seminar makes students notice that "It is important to understand the background of thinking to learn the multidisciplinary field of study". Most of students continue their research activity to the post graduate course.

5. CONCLUSION

A cross-cultural student program has been designed for communication training in the multidisciplinary research area. Students from a variety of backgrounds of research area and culture have joined in the program. The program works well for communication training in the multidisciplinary research area of biomedical engineering. The experience in the program helps students not only understand new idea in the laboratory visit, but also make a presentation in international research conferences.

6. ACKNOWLEDGMENT

Author is thankful to Dr. Mana Sriyudthsak of Chulalongkorn University, Dr. Jackrit Suthakorn of Mahidol University, Prof. Robert A. Linsenmeier of Northwestern University, to Prof. Richard L. Magin of University of Illinois at Chicago, for collaboration to our project.

REFERENCES

[1] R.A. Linsenmeier, "What Makes a Biomedical Engineer: Defining the Undergraduate Biomedical Engineering Curriculum", **IEEE Engineering in Medicine and Biology Magazine**, Vol. 23(4), 2003, pp. 32-38.

[2] S. Hashimoto, et al., "Parallel Curriculum of Biomedical Engineering Subjects with Rotational Experimental Project for Interdisciplinary Study Field", **Proc. 11th World Multiconference on Systemics Cybernetics and Informatics**, Vol. 4, 2007, pp. 39-44.

[3] S. Hashimoto, et al., "Parallel Curriculum between Application and Fundamental Subjects with Rotational Experimental Project for Multidisciplinary Study Field of Biomedical Engineering", **Proc. 12th World Multi-conference on Systemics Cybernetics and Informatics**, Vol. 2, 2008, pp. 98-103.

[4] S. Hashimoto, et al., "Bridging-Charge System for Sustained Improvement of Curriculum of Biomedical Engineering Courses", **Proc. 13th World Multi-conference on Systemics Cybernetics and Informatics**, Vol. 2, 2009, pp. 191-195.

[5] S. Hashimoto, "Bridge-Curriculum with Rotational Experimental Projects for Multidisciplinary Courses on Biomedical Engineering", **Proc. 14th World Multi-conference on Systemics Cybernetics and Informatics**, Vol. 2, 2010, pp. 261-264.

[6] S. Hashimoto, "Bridge-Curriculum System for Multidisciplinary Courses: Application to Biomedical Engineering", **Proc. 15th World Multi-conference on Systemics Cybernetics and Informatics**, Vol. 2, 2011, pp. 108-111.

[7] S. Hashimoto and A Nakajima, "Role of Bridge-Curriculum for Multidisciplinary Courses: Application to Biomedical Engineering", **Journal of Communication and Computer**, Vol. 8 (12), 2011, pp. 1117-1122.

[8] S. Hashimoto, "Cross-Cultural Student Seminar for Communication Training in Multidisciplinary Field of Study: Application to Biomedical Engineering", **Proc. 16th World Multi-conference on Systemics Cybernetics and Informatics**, Vol. 2, 2012, pp. 87-90.

[9] S. Hashimoto, "Interdisciplinary Area of Research Offers Tool of Cross-Cultural Understanding: Cross-Cultural Student Seminar for Communication Training on Biomedical Engineering", **Journal of Systemics Cybernetics and Informatics**, Vol. 11, No. 9, 2013, pp. 17-22.

The Smarter Planet: Built on Informatics and Cybernetics

Fred A. MAYMIR-DUCHARME, Ph.D.,
Executive Architect, IBM US Federal CTO Office, FredMD@us.ibm.com
Adjunct Professor, University of Maryland University College (UMUC), USA

and

Lee A. ANGELELLI
Analytics Solution Center Architect, IBM US Federal CTO Office, LAngelel@us.ibm.com

ABSTRACT

IBM's Smarter Planet initiative is a multi-disciplined approach that integrates the key tenets of the IMSCI 2014 (The 8th International Multi-Conference on Society, Cybernetics, and Informatics) conference [1]. Industry has seen a tremendous explosion of data growth. Organizations that dealt with Terabytes (TB) and Petabytes (PB) just a couple of years ago are now faced with the challenge of dealing with Exabytes (EB) of data. An Exabyte is 10^{18} Bytes – a million times a billion bytes! The amount of information available today is truly remarkable; so much that it is considered by many in industry as a new "natural resource." Computing has similarly grown and made major advances. Today's fastest supercomputer is a 33.8 PFLOPS machine (33.8 x 10^{15} floating point operations per second) and applies analytics to predict weather to a degree that was unimaginable ten years ago. The Smarter Planet approach goes beyond the traditional data sources to include a plethora of sensor data (e.g., utility readings, concrete pressure sensors on a bridge, etc.) and applies analytics to provide new Informatics, which in turn can be used to advance new Cybernetics (e.g., Smarter Buildings, Smarter Cities) to address Societal needs in new, innovative ways. [2]

Keywords: Smarter Planet, Informatics, Cybernetics, Advanced Analytics, Big Data, Knowledge Management

1.0 INTRODUCTION

The focus of this paper is on the role of Informatics and Cybernetics [1] in the evolution of IBM's Smarter Planet initiative, and a brief description of the underlying computer (data processing) technology advances Smarter Planet is built on. Whereas a traditional Knowledge Management (KM) system [3] [4] automates the Cybernetics and Informatics that an organization utilizes to run various aspects of its business, one can envision the world as the composition of numerous organizations (governments, industries, academic institutions, and even individuals) working together towards common or inter-related goals and objectives. Advanced Analytics can be applied to increase the effectiveness and efficiency of traditional KM systems. [5]

In a seminal speech to the Council of Foreign Relations, IBM Chairman and CEO Sam Palmisano first noted some grand challenges observed world-wide, as a result of several Global Innovation Outlook (GIO) Summit meetings IBM sponsored with leaders and technologists around the world:

> ***"How much energy we waste:*** *According to published reports, the losses of electrical energy because grid systems are not "smart" range as high as 40 to 70 percent around the world.*
>
> ***How gridlocked our cities are:*** *Congested roadways in the U.S. cost $78 billion annually, in the form of 4.2 billion lost hours and 2.9 billion gallons of wasted gas—and that's not even counting the impact on our air quality.*
>
> ***How inefficient our supply chains are:*** *Consumer product and retail industries lose about $40 billion annually, or 3.5 percent of their sales, due to supply chain inefficiencies.*
>
> ***How antiquated our healthcare system is:*** *In truth, it isn't a "system" at all. It doesn't link from diagnosis, to drug discovery, to healthcare deliverers, to insurers, to employers. Meanwhile, personal expenditures on health now push more than 100 million people worldwide below the poverty line each year.*
>
> ***How our planet's water supply is drying up:*** *Global water usage has increased six-fold since the 1900s, twice the rate of human population growth. According to the Asian Development Bank, one in five people living today lacks access to safe drinking water, and half the world's population does not have adequate sanitation.*
>
> ***And, of course, the crisis in our financial markets:*** *This will be analyzed for decades, but one thing is already clear. Financial institutions spread risk but weren't able to track risk—and that uncertainty, that lack of knowing with precision, undermined confidence." [2]*

Recognizing IBM's unique opportunity to provide new leadership and leverage the corporation's 100 years of technical innovation, inventions, and awards [6], Mr Palmisano described IBM's commitment to "building a smarter planet" and the key tenets of the Smarter Planet initiative:

> ***"First, our world is becoming instrumented:*** *The transistor, invented 60 years ago, is the basic building block of the digital age. Now, consider a world in which there are a billion transistors per human, each one costing one ten-millionth of a cent. We'll have that by 2010. There will likely be 4 billion mobile phone subscribers by the end of this year… and 30 billion Radio Frequency Identification tags produced globally within two years. Sensors are being embedded across entire ecosystems—supply-chains, healthcare networks, cities…even natural systems like rivers.*
>
> ***Second, our world is becoming interconnected:*** *Very soon there will be 2 billion people on the Internet. But in an instrumented world, systems and objects can now "speak" to one another, too. Think about the prospect of a trillion connected and intelligent things—cars, appliances, cameras, roadways, pipelines… even pharmaceuticals and livestock. The amount of information produced by the interaction of all those things will be unprecedented.*
>
> ***Third, all things are becoming intelligent:*** *New computing models can handle the proliferation of end-user devices, sensors and actuators and connect them with back-end systems. Combined with advanced analytics, those supercomputers can turn mountains of data into intelligence that can be translated into action, making our systems, processes and infrastructures more efficient, more productive and responsive—in a word, smarter." [2]*

This paper describes the innovation and technologies behind the Smarter Planet imitative, which represents a state of the art application of Informatics and Cybernetics fundamentals.

2.0 AUTONOMIC COMPUTING

Enterprise Systems Management (ESM) has evolved over the last forty years, as the size and complexity of systems within organizations have grown. The administration and support of the many system elements (e.g., servers, storage and networks) becomes increasingly challenging as an organization transitions to managing heterogeneous systems across their enterprise. Even today, the majority of our industry struggles to manage system outages, configuration changes, performance tuning, and many other ESM challenges. The Autonomic Computing vision emerged from decades of research and development focused on increasing ESM automation and decreasing the need for human intervention. The term "autonomic" is used to connote the unprecedented level of automation the human body has – i.e., our autonomic nervous systems, which subconsciously governs numerous, complex body functions. For example, our body autonomously measures oxygen levels, body temperature, blood sugar levels, etc. – and then automatically changes respiration, circulation and digestion to dynamically address issues. One doesn't think about increasing one's breathing and circulation when climbing stairs; that's done autonomously by the body in order to control the anomalous exertion being forced on the body.

2.1 TENETS OF AUTONOMIC COMPUTING

Autonomic Computing (AC) has four tenets: Self Configuring, Self Healing, Self Optimizing, and Self Protecting. [7]

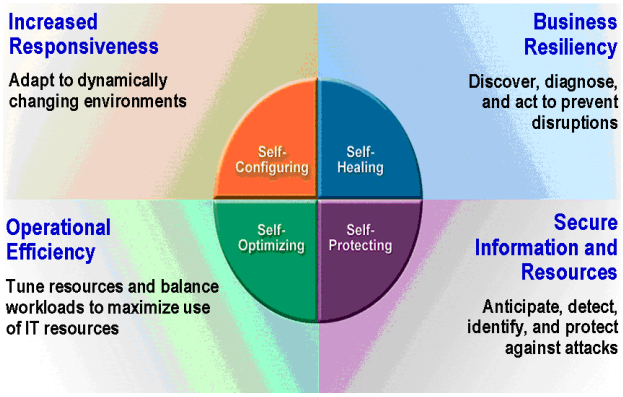


Figure 1: Autonomic Computing Tenets

These tenets, illustrated in the figure above, include the following capabilities:

Self Configuring – Many of today's corporate data centers have a variety of components from a variety of vendors. Installing, configuring, and integrating components is time consuming and error-prone. The AC vision is to automate the configuration of components and systems according to high-level policies; and the rest of the system adjusts automatically.

Self Healing– Determining problems in large, complex systems today can take a team of programmers and system administrators multiple weeks. The AC provides automated detection, diagnosis and resolution to localized software and hardware problems.

Self Optimizing – Today's hardware and software contain hundreds of measurements, diagnostics, alarms, and many more tuning options and parameters. The AC strategy is to continuously seek opportunities to improve performance and efficiency.

Self Protecting – The majority of today's mechanisms for protecting and detecting system attacks and failures are silo'ed and are slowly beginning to use standard security naming conventions. The AC approach is to correlate the information from many disparate protection and detection system elements, to automatically identify and defend against malicious attacks and cascading failures, to provide early warning, and to prevent system-wide failures.

2.2 AUTONOMIC COMPUTING ABSTRACTIONS

A novel aspect of the AC vision is the goal of making decisions that take multiple perspectives into consideration. This can be accomplished with contextual analytics, which provide views of the system elements from various levels of abstraction.

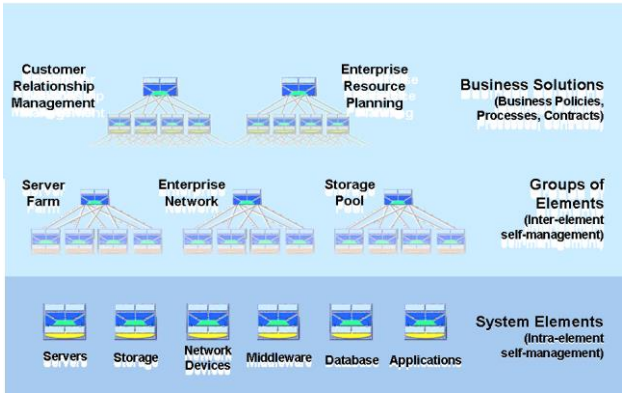


Figure 2: Autonomic Computing Abstraction Levels

Figure 2 illustrates three different views of the same system elements, but with a variety of relationships within different contexts. The lower level abstraction views system elements as a stand-alone entity, and only considers the type of element and vendor specific informatics when diagnosing problems and selecting corrective action. The middle level abstraction looks at the aggregation of similar elements (e.g., a pool of servers) and would extend the diagnostics and problem resolution to consider things such as load balancing, disaster recovery policies, etc.

The top level abstraction takes on a very different perspective. In this example, the top level abstraction places system elements within the context of the corporate missions the system supports. One might place a higher priority on keeping lighter computing loads on mission critical system elements, rather than uniformly spreading computing loads across an enterprise-wide server farm.

2.3 AUTONOMIC COMPUTING CYBERNETICS

The AC design is built on the premise that one must be able to *measure, make a decision, and control* system elements at all of the abstraction levels (as described in the example in Section 2.2). This is called the AC *control loop*. Control loops are designed to provide the self-configuring, self-healing, self-optimizing, and self-protecting capabilities.

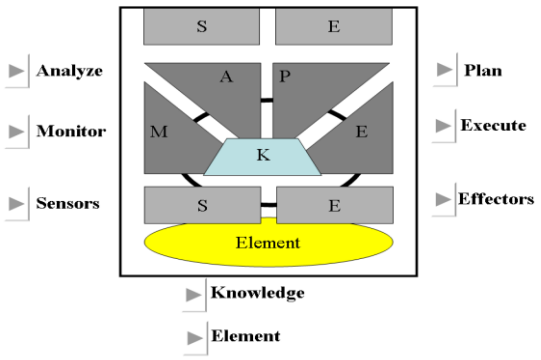


Figure 3: Autonomic Computing Control Loop Component

Figure 3 illustrates the composition of the AC control loop components. The **monitor** sub-component includes mechanisms that collect, aggregate and filter element data (*measures*) from sensors associated with the specific element being controlled. The **analyze** sub-component is made up of mechanisms that model or analyze complex situations within the scope of the control loop. The **plan** sub-component decides the actions needed to achieve the desired goals and objectives. (Note : Analyze and Plan are used to support the "*decide*" phase of the AC control loop.) The decision logic has embedded "act, monitor and learn" functions, which verify the plan successfully solved the problem or achieved the desired outcome. The **execute** sub-component executes the actions planned, supporting the *control* phase of the AC control loop. The **knowledge** sub-component represents the KM associated with the controlled element, and continuously grows as it stores the information that's been measured, analyzed, planned, and executed – and the ensuing results.

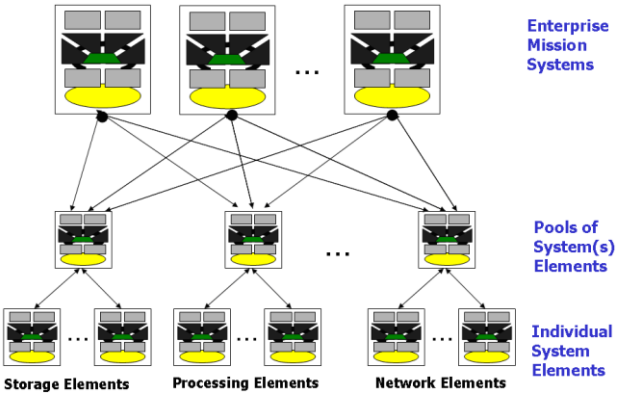


Figure 4: Autonomic Computing Hierarchical Design

Note that the AC control loop structure illustrated in Figure 3 has sensors and effectors at the top and at the bottom. This design provides the ability to manage a single system entity, a pool of entities, or the aggregation of multiple entities -- i.e., in support of the various system levels of abstraction described in Section 2.2 and illustrated in the hierarchical figure above.

It should be noted that AC is not a product. It is a vision that can be implemented at various levels of automation (e.g., self-healing and self-protection), and support many system level abstractions (e.g., resource pools or mission systems). As Information Technology (IT) matures, system elements have improved the information provided through "sensor" interfaces, and have increased the element commands that can be specified through "effector" interfaces to the system element.

3.0 BUILDING A SMARTER PLANET

The authors contend that Autonomic, which focused on enterprise systems management and large data centers, was the technical predecessor to the Smarter Planet initiative. Smarter Planet extends the scope of sensors well beyond the traditional system elements (e.g., servers, storage, networks, etc.) and applies advanced analytics to support a much broader set of informatics, inter-related abstractions (societal areas) and cybernetics. The authors recognize there were numerous other technical and non-technical advances that contributed to the evolving Smarter Planet campaign.

Whereas Autonomic Computing acted on informatics provided from system elements, Smarter Planet's cybernetics approach is to act on informatics from any type of data source – ranging from a utility meter or pressure sensor on a bridge, to mobile devices such as mobile phones and traffic cameras, or even passive micro-chips embedded in a pet or human being.

The Smarter Planet cybernetics is built on three tenets:

1. **Instrumented**: anything with a sensor can be an **Informatics** element. As previously described some sensors are uni-directional (they only provide data, or they simply accept commands). The more useful elements are bi-directional and do both!
2. **Interconnected**: A smarter planet sensor must be interconnected (preferably to the internet, or a hub computer w/ access to the internet), otherwise one loses a tremendous amount of automation by having to include a human in the loop (to read the data and enter it into the system). Some sensors need their data to be converted (e.g., analog to digital, or proprietary representations to industry standard representations).
3. **Intelligent**: And a smarter planet solution is built on intelligent processing **(Cybernetics**) – exploiting advanced analytics to optimize effectiveness and efficiencies from every possible perspective

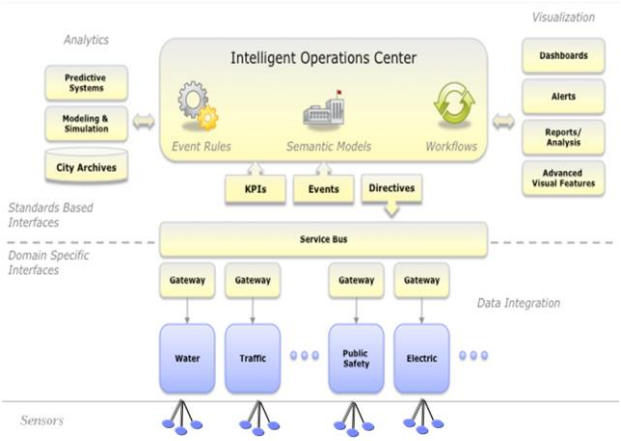


Figure 5: Intelligent Operations Center (IOC)

The Intelligent Operations Center (IOC) is the framework that enables the Smarter Planet to leverage different types of sensors (instrumented sensors and data sources), integrate the sensor data (provide interconnectivity), apply advanced analytics (intelligence) and then define and automate the smarter cybernetics. Like the AC Control Loop Component, it supports the closed-loop cycle to the degree supported by the associated sensor instrumentation.

In the speech Palmisano gave at the Council on Foreign Relations in New York City on November 6, 2008, he discussed IBM's Smarter Planet vision – a new strategic agenda for progress and growth. Palmisano outlined the premise of a smarter planet and the coming of age of a whole new generation of intelligent systems and technologies—more powerful and accessible than ever before.

It provided a way for industries, infrastructures, processes, cities and entire societies to be more productive, efficient, and responsive. Given the data explosion and computing advances of the previous millennium, Palmisano believed there was an opportunity to address the problems and challenges that were gripping the world during 2008. A world capable of making more intelligent decisions—from smarter power grids, to smarter food systems, smarter water, smarter buildings, smarter healthcare, and smarter traffic systems.

Palmisano recognized that everything (including cars, power grids, transportation, phones, etc.) was becoming more instrumented and interconnected. This technology phenomenon produced more volumes, velocity, variety, and veracity (four Vs of Big Data) of information and data being captured than ever before.

By 2010, governments and industries were no longer questioning the Smarter Planet vision nor values – they were looking for knowledge and experience on how to create Smarter Planet solutions. Some of these are included in the figure below.

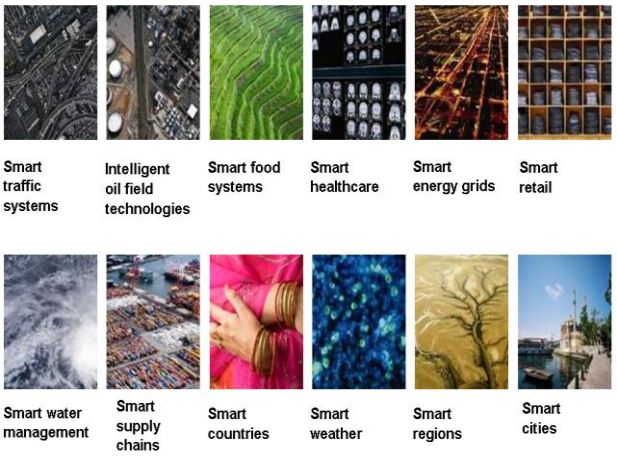


Figure 6 – Smarter Planet Building Blocks

On January 12, 2010, Sam Palmisano kicked off the new year and decade with a follow-up to the Smarter Planet speech with a new speech called "The Decade of Smart" at the Chatham House in London, England which evolved the Smarter Planet initiative into a multiplatform strategy promoting the way in which IBM technology and know-how helps industry, government, transportation, energy, education, healthcare, cities, and other businesses work smarter and contribute to building a smarter planet. Sections 3.1 and 3.2 describe the more mature "Smarter Buildings" and "Smarter Cities" solutions in more detail.

3.1 SMARTER BUILDINGS

In the U.S., buildings consume 70% of all electricity, up to 50% of which is wasted. Commercial buildings lose as much as 50% of the water that flows into them. By 2025, buildings will be the single largest energy consumers and emitters of greenhouse gasses on our planet. [8] In an attempt to reduced buildings' wasted resources – over the last decade, building owners have installed smart sensors and control systems that can detect and sense various conditions and emit alerts or responses of many disparate systems. These efforts have only lead to minimal costs savings. The challenge for many building owners is how do you collect the Big Data 4V's from the silo information to provide operational and performance improvements in the building. This is a comprehensive effort because most of the building systems (energy, heating, lighting, water, security and other specialized systems) operate independently, through a mix of vendors, and have different protocols and transport mechanisms.

Building managers think and manage buildings along three dimensions: energy, operations, and space. They need to know where are opportunities to save energy; identify operational and/or capital improvements; and ability to optimize utilization of buildings space. The IBM Smarter Building solution solves these building managers' problems by addressing these key challenges: energy and asset management, building operations management, and effective space utilization. The IBM Smarter Building solutions set has the following main areas:

Energy management - energy management is the real-time monitoring of building and data center equipment. It reduces energy consumption and waste over the life cycle of a building and increases facility performance in a sustainable manner.

Operations management - operations management includes asset management and performance, utilization, availability, and life-cycle management. The portfolio of building assets is optimized through asset visibility and operations management.[8]

As shown in Figure 7 - the IBM Smarter Building solution was built and designed around the elements of *visualization, intelligence, interconnected, instrumented,* and *physical.* These solution capabilities enable building managers to: integrate and optimize the physical and digital infrastructure of buildings; create facilities that are more cost-effective, operationally efficient, productive, safe, secure, and environmentally responsible; gather data, manage assets, monitor sensors, centralized analytics optimization; and distributed control. These Smarter Building solution capabilities will enable the integration of a city's buildings. When interactions between a city and buildings exist, the buildings can contribute to the health of the city. The city as a whole can reduce energy consumption and carbon dioxide (CO2) emissions by 50–70%, energy usage reduced by up to 40%, maintenance cost 10-30%, and save 30–50% in water usage.

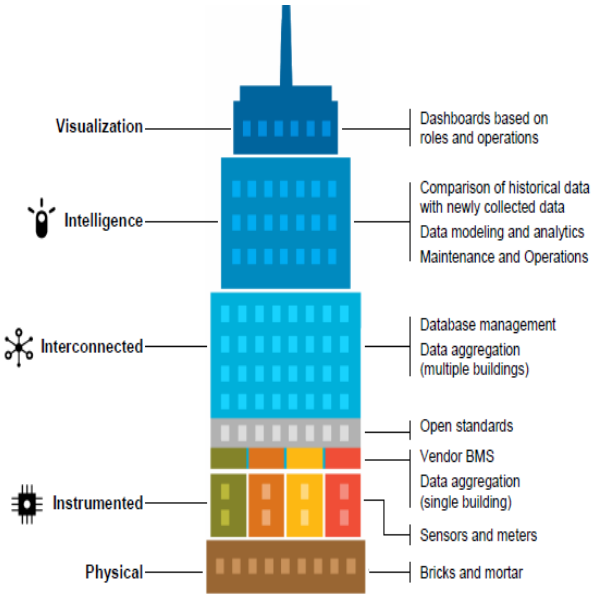


Figure 7 – Smarter Building Architecture Elements

3.2 SMARTER CITIES

Governments and business are faced with shrinking budgets and limited resources but need to meet demanding pressures to improve energy consumption, traffic gridlock, aging infrastructure, healthcare services, financial markets, food production, etc. to spur economic growth and improve quality of life for citizens. Government officials couldn't meet these challenges because most critical information is often stored in disparate systems across disconnected departments, hindering a clear view of the operational picture and increasing the difficulty of coordinating agency efforts. Without a single, integrated view of events, incidents or impending crises, and without the ability to rapidly share information, a city might be unable to effectively deliver services in a sustainable fashion, protect citizens or drive future economic growth. [10]

Government officials and industry involved in city development or federal response services have applied a variety of IOC-based solutions that provide a centralized operations dashboard to help city leaders gain insight into various aspects of city management or federal responses. The centralized operations dashboard spans agencies and enables drill-down capability into underlying agencies, such as emergency management, public safety, social services, transportation, or water. This approach enables cities to manage large complex environments,

communicate more effectively with citizens, understand the state of the city and collaborate between departments. This saves cities money by reducing staff needed to make decisions and by more effectively deploying resources.

These IOC capabilities provide leading cybernetic technologies where systems are involved in a closed signaling loop; that is, where action by the system generates some change in its environment and that change is reflected in that system in some manner (feedback) that triggers a system change. This solution offers integrated data visualization, real-time collaboration and deep analytics that can help city/federal agencies prepare for problems before they arise and coordinate and manage problems as they occur, to enhance the ongoing efficiency of city operations. Executive dashboard capabilities give decision makers a real-time, unified view of operations so they can see who and what resources are needed and available. Cities, federal agencies, and industry can share information instantly across agency lines to accelerate problem response and improve project coordination. [9]

In the past, individual city agencies often focused only on their own operations and were unable to share information with other agencies and departments. The IOC is designed to help multiple agencies and departments share information — such as metrics, events and processes — and collaborate in near-real time, allowing cities to better anticipate and respond to situations while optimizing limited resources.

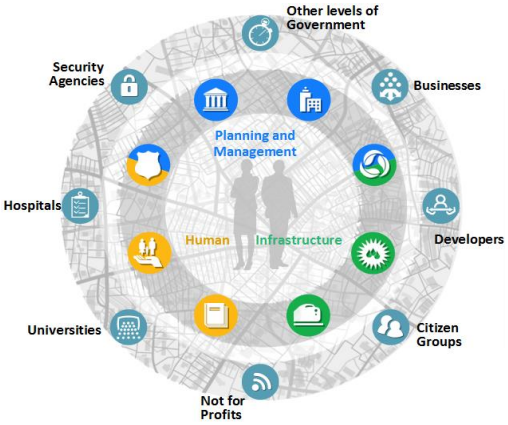


Figure 8 – City Development Management

The IOC framework has been successful implemented in various Smarter Cities world-wide. For instance – the city of Rio de Janeiro teamed with IBM to develop a Smarter City solution – Rio Operations Center that provides city officials with new capabilities to further improve the city's emergency response system, and give citizens access to information that will help them better manage their daily lives. Since opening less than a year ago, the Rio Operations Center has integrated information and processes from across 30 different city agencies into a single operations center that provides a holistic view of how the city is functioning on a 24 by 7 basis. The Operations Center serves as the nerve center for the city, applying analytical models developed by IBM to more effectively predict and coordinate reaction to emergency incidents. [10]

> "In Rio de Janeiro, we are applying technology to benefit the population and effectively transitioning to a smarter city," said Mayor of Rio de Janeiro Eduardo Paes. "In addition to using all information available for municipal management, we share that data with the population on mobile devices and social networks, so as to empower them with initiatives that can contribute to an improved flow of city operations." [10]

Operations officials from across the city now collaborate daily to manage the movement of traffic and public transportation systems, and the efficiency of power and water supplies. The Center also relies on a system pioneered by IBM Research scientists -- a high-resolution weather forecasting and hydrological modeling system for Rio de Janeiro, which can predict heavy rains up to 48 hours in advance. The forecasting system is based on a unified mathematical model of Rio that pulls data from the river basin, topographic surveys, the municipality's historical rainfall logs, and radar feeds. The system predicts rain and possible flash floods, and has also begun to evaluate the effects of weather incidents on other city situations such as city traffic or power outages.

4.0 CONCLUSIONS

We have seen tremendous advances in data processing (computer) technology in the last half century. There were three major technology advancement waves that essentially defined computing in the enterprise. In the 1960s, the advent of the IBM System 360 revolutionized business processes "back office" management – introducing automated systems management. The 1980s transformed the computing power of earlier mainframes to considerably smaller computers, which were ultimately named "personal computers" (PCs). The PC's "client-server" computing model provided employees across the enterprise considerably more autonomy -- e.g., not being required to be connected to the "back-end system" and the versatility that came with new PC applications. And we then saw the birth of the World Wide Web in the 1990s and early 2000s, as the Internet evolved, was commercialized, was a catalyst to the creation of e-Business.

We are likely on the cusp of a fourth wave, which is characterized by the confluence of Big Data, Advanced Analytics, Social Computing, Mobile Computing, and Cloud Computing. This confluence of technologies (sometimes referred to as the Internet of Things) is again transforming the way companies world-wide deliver and consume millions of systems, software and services. The confluence of these technologies is enabling four mega-trends (each with significant societal implications, and advanced capabilities enabling a Smarter Planet):

> **"Growing Scale / Lower Barrier of Entry:** A massive expansion in the number of smart devices, sensors, transactions and users of digital technologies is creating huge amounts of structured and unstructured data — while the rise of easy-to-use and affordable programming interfaces is simultaneously lowering the barrier of entry for companies to create applications and services that derive value from this data.
>
> **Increasing Complexity / Yet More Consumable:** While the volume, variety, velocity, and veracity of data is contributing to the increasing complexity of data management and workloads — creating a greater need for advanced analytics to discover insights — mobile devices have made technology more consumable, creating user demand for interactive tools for visual analytics.
>
> **Fast Pace:** Change is coming faster than ever — disruptive models for the development and consumption of technology are emerging to penetrate global enterprise ecosystems, resulting in rapid innovation and decreased time-to-value. Open online courses are experiencing exponential growth making education and training more accessible.

> **Contextual Overload:** The proliferation of sensors and devices and the explosive growth in structured and unstructured data are causing information and contextual overload. With the increasing affordability and sophistication of smart devices, new opportunities exist to provide contextually aware and personalized services based on user views, desires, preferences and location, delivered just-in-time." [11]

Technology today is what's enabled the Smarter Planet initiative. One could have conceptually described the value of the many Smarter Planet views in the past; but one could not have had a pragmatic discussion as to how to implement it in the last millennium. The world is flat, connected, and global. The world is evolving at a rapid pace. The World Health Organization (WHO) estimates that the majority of the world population now lives in a city

> "Urbanization, the demographic transition from rural to urban, is associated with shifts from an agriculture-based economy to mass industry, technology, and service. For the first time ever, the majority of the world's population lives in a city, and this proportion continues to grow. One hundred years ago, 2 out of every 10 people lived in an urban area. By 1990, less than 40% of the global population lived in a city, but as of 2010, more than half of all people live in an urban area. By 2030, 6 out of every 10 people will live in a city, and by 2050, this proportion will increase to 7 out of 10 people. Currently, around half of all urban dwellers live in cities with between 100 000 - 500 000 people, and fewer than 10% of urban dwellers live in megacities (defined by UN HABITAT as a city with a population of more than 10 million)." [12]

The perdurable world-wide migration from urban settings to cities fuels the need for a Smarter Planet. It is estimated that:
Smarter traffic systems can cut gridlock by 20%; and
Smarter energy systems can reduce energy waste by 15% or more. The perpetual increase in size and complexities of cities and mega-cities makes it essential for governments to adopt smarter approaches and smarter technology. The industries that have emerged around smarter buildings, and smarter energy (e.g., Energy Service Companies and Energy Management Systems) provide evidence that the world is moving in this direction.

> Globally, urban growth peaked in the 1950s, with a population expansion of more than 3% per year. Today, the number of urban residents is growing by nearly 60 million every year. The global urban population is expected to grow roughly 1.5% per year, between 2025-2030. By the middle of the 21st century, the urban population will almost double, increasing from approximately 3.4 billion in 2009 to 6.4 billion in 2050. Almost all urban population growth in the next 30 years will occur in cities of developing countries. Between 1995 and 2005, the urban population of developing countries grew by an average of 1.2 million people per week, or around 165 000 people every day. By the middle of the 21st century, it is estimated that the urban population of these counties will more than double, increasing from 2.5 billion in 2009 to almost 5.2 billion in 2050" [12]

Emerging countries and the rate at which some have grown further validate this confluence of technology; but more importantly, they also present a very interesting opportunity. The cost of "modernizing" a long standing, well established city will notionally cost more than building a smart city "starting from scratch." But starting from scratch is not an option for a city that depends on infrastructure, governance, and the many other services that would have to be placed on hold during a re-building exercise. The opportunity is there for emerging countries to make intelligent decisions in the design and development of cities – e.g., making early investments in instrumentation, interconnectivity, and ultimately intelligent systems that could help these countries "leap frog" the older technologies and processes that many cities today are in the process of modernizing.

This paper provided a variety of perspectives on the Smarter Planet initiative, the many underlying technologies that make it possible today, and the underlying academic concepts from the field of informatics and cybernetics that have guided its evolution. This paper only discussed a subset of the many industries and "smarter solutions" that have blossomed in the last several years. The next generation of Smarter Planet systems will inevitably exploit other advanced technologies, such as Cognitive Computing [5] Imagine the ability to have a bi-directional discussion with a Smarter Planet system that can reason and adjust itself as it learns from its empirical data and augments the data with human guidance.

ACKNOWLEDGEMENTS

The authors wish to thank Kevin Brown (Solution Architect, IBM Federal CTO Office) and David Jenkins (Executive Architect, IBM Federal CTO Office) for their technical review comments and discussions.

REFERENCES

[1] Callaos, Nagib (March, 2013), http://www.iiis.org/Nagib-Callaos/Cognition-and-Knowledge
[2] Palmisano, Sam "A Smarter Planet: The Next Leadership Agenda," Speech to the Council on Foreign Relations, New York, NY, 6 November 2008, http://www.ibm.com/ibm/ideasfromibm/ca/en/smartplanet/20090210/sjp_speech.shtml
[3] Nonaka, I. and Takeuchi, H. (1995) *The Knowledge-Creating Company*, Oxford: Oxford University Press
[4] Gal, Y. et al. "A Model of Tacit Knowledge and Action," IEEE Computational Science and Engineering, 2009 International Conference p. 463-468.
[5] Maymir-Ducharme, Fred and Angelelli, Lee "Cognitive Analytics: A Step Towards Tacit Knowledge?" proceedings of the 8th International Multi-Conference on Society, Cybernetics and Informatics, July 2014
[6] Maney, Steve Hamm, and Jeffrey M. O'Brien, *Making the World Work Better: The Ideas That Shaped a Century and a Company*, IBM Press / Pearson, 16 June 2011
[7] Kephart, Jeffrey O. and Chess, David M. "The Vision of Autonomic Computing" Journal COMPUTER, Vol. 36, Issue 1, January 2003. IEEE Computer Society Press, Los Alamitos CA
[8] Brech, Brad et al. "Smarter Cities Series: Understanding the IBM Approach to Efficient Buildings" June 2011 (unpublished)
[9] IBM Software Group - Industry Solutions Division "IBM Intelligent Operations Center for Smarter Cities" July 2012 (unpublished)
[10] "IBM City of Rio de Janeiro and IBM Collaborate to Advance Emergency Response System; Access to Real-Time Information Empowers Citizens" http://www.ibm.com/press/us/en/pressrelease/35945.wss
[11] IBM Global Technology Outlook, IBM Research. April, 2013 (unpublished)
[12] Global Health Organization's "Global Health Observatory" http://www.who.int/gho/urban_health/situation_trends/urban_population_growth_text/en/

Casting a Wide Net for Innovation: Bringing Interdisciplinary Collaboration to Real World Problems

Dr. R. Cherinka and Mr. J. Prezzama
The MITRE Corporation
4830 W. Kennedy Blvd., Tampa, FL 33609
Phone: 813-287-9457, Fax: 813-287-9540
rdc@mitre.org, prezzama@mitre.org

ABSTRACT

Federal agencies are seeking new ways to innovate, procure and enhance enterprise capabilities. Competitions are one tool that federal agencies can use to drive innovation and solve mission-centric problems—whether technical, scientific, or creative. In this paper we present an examination of several approaches to foster open innovation through challenges and competitions in support of key business operations in the workforce. We highlight specific examples of their use in "real world" environments and provide an assessment of applicability, benefits and challenges for implementation in large organizations.

Keywords: Continuous Innovation, Challenge-Based Acquisition, ChBA, Competitions, Gamification

1. INTRODUCTION

In this presentation, we discuss the utility of bringing interdisciplinary collaboration to real world problems. Modern organizations are facing similar and diverse challenges every day [2]. They are coping by:

- Leaders setting sound strategic visions;
- Utilizing Infrastructures and test-beds for information sharing, experimentation & prototyping;
- Embracing interdisciplinary sources that are open to the communities (such as government agencies, academia, subject matter experts (SMEs) etc.)

The objective is to have a rich set of innovative interdisciplinary resources at our disposal to utilize in meeting the business and innovation goals of an organization.

This could result in diverse partnering and teaming arrangements and for creating new ways of thinking. Considering recent Government guidance for increased use of challenges and prizes to develop new tools and approaches to improve open government [12], we examine several approaches to foster open innovation through challenges and competitions in support of key business operations in the workforce, and we highlight specific examples of their use in "real world" environments [9].

2. BACKGROUND

In past conferences, we discussed approaches to foster open innovation, including the use of crowds and social media to leverage and utilize interdisciplinary sources for continuous innovation [2, 3].

We defined the meaning of the term "Interdisciplinary"…within the context of education and training disciplines. Specifically in this context, the term Interdisciplinary involves researchers, students, engineers and teachers with the goal of connecting and integrating several academic schools of thought, professions, or technologies - along with their specific perspectives - in the pursuit of a common task [6, 7]. We highlight:

- The most common barriers to true innovation, as well as Technologies & trends that we believe, will fuel the spark of innovation in the near future.
- Several approaches to foster open innovation, including the use of crowds and social media for continuous innovation.
- The crowd-sourcing model and its potential value applied to commercial and government environments.
- The perils of "Group Think" associated with these approaches.

Additionally, we found that Interdisciplinary sources are available and leveraged every day, and they are becoming ubiquitous. New technological trends and approaches, when taken together, offer unprecedented access to

information, people and even group sentiment, offering new ways to collaborate, connect producers to consumers to investors, and ultimately to innovate. We also discovered that large enterprises that can adapt to using new approaches have a golden opportunity to foster new approaches for open and continuous innovation success by:

- Embracing culture change,
- Fostering business model change for new innovation,
- Adapting to new & enabling technologies,
- Creating tipping points in public opinion and social attitudes,
- Leveraging shifts in policy and regulation,
- Acknowledging the emergence of new business models, and the disruption resulting from unpredictable events

In order to optimize success, the goal for these organizations is to have a rich set of innovative interdisciplinary resources at their disposal to utilize in order to meet business objectives.

3. THE POWER OF THE CHALLENGE

Federal agencies are seeking new ways to innovate, procure and enhance enterprise capabilities. Casting a wider net to tap into interdisciplinary sources to encourage partnering and teaming to help bring talent and innovation to solving hard problems is one way to enhance innovation.

Traditional acquisition processes often require a deep understanding of requirements and a profound knowledge of the potential solutions that are available in the market place [11]. These traditional approaches used within the Government are very cumbersome. In fact, the Government Acquisition process was designed for large weapon systems development, not software systems. For example, a typical acquisition length is 5 – 10 years. Traditional methodologies such as this are considered to be "heavy weight" and can be characterized by:

- Up-front planning
- Formal documentation
- Linear phase approaches (requirements, design, test, integration, user delivery)
- Plan driven

As a result, these approaches typically have demonstrated a high rate of failure with respect to IT projects as they are often are delivered late, over-budget, or do not satisfy requirements. As a result, organizations are investigating the use of Agile software development acquisition processes. The key difference between agile development and a more traditional approach, is that agile is an incremental, iterative and collaborative approach, with no distinct stages of the development lifecycle.

As part of the agile initiative, competitions and challenges are one tool that federal agencies are using to drive innovation and solve mission-centric problems—whether technical, scientific, or creative. Challenges are everywhere. Some organizations have chosen to conduct Challenge-based Acquisition (ChBA) performed in a contest-like manner to encourage greater innovation and private sector participation.

At its core, the use of ChBA, allows the government to communicate its needs through challenges that are analogous or identical to a desired capability. Then, industry would respond to the challenges without extraneous constraints. In turn, these challenges can abstract away irrelevant concerns and can in many cases be substitutes for loose requirements. The basis for ChBA can be found in the application of game theory, or "gamification" [10]. Gamification is the use of game thinking and game mechanics in non-game contexts to engage users in solving problems.

4. EXTENDING INNOVATION IN THE WORKFORCE

An example of innovation in the worforce is highlighted by a Government project using challenges as part of seeking new ways to acquire capabilities.

The Tactical Assault Light Operator Suit (TALOS), is a vision to integrate science and technology capabilities into an integrated suit that better protects a warfighter and/or first responder. The intent is to accelerate the delivery of these innovative capabilities to the warfighter. Prior studies and analysis have determined a number of technical challenges exist that require improvements in equipment for future missions, such as 1) balancing the trade space between weight, protection, power, mobility, 2) cost, and 3) system component integration. A TALOS suit would comprise layers of smart material, sensors, communications radios and other capabilities for better enabling and protecting soldiers during combat situations [16].

In this example, the Government is seeking innovations from industry, academia, individuals, and Government Labs capable of providing the design, construction, and testing of TALOS related technologies. It is an interactive process designed to assess the viability of technologies

while simultaneously refining user requirements. They are using Google hangouts, monster garage "hackathons", and technology workshops to motivate the entire community to team and work together throughout the innovation process. As solutions mature, the most viable options will be selected as the reference implementation for acquisition

There are several key characteristics associated with workforce innovation that are illustrated in this example. The first characteristic that stands out is motivation. There needs to be a good business reason or challenge to solve that motivates stakeholders. It is ok to have loose requirements or a vague idea at the start, allowing for requirements to emerge over time. However, once that need is determined, there needs to be commitment. Senior Leadership needs to embrace and own the problem and seek to provide resources and set the tone for innovation. In the TALOS example, the government leadership had the motivation of protecting warriors, and it became the commanders' number one priority for innovation from the Science and Technology communities. The motivation was so strong that he approved the use of non-traditional acquisition approaches to solve the challenge.

Another characteristic is collaboration, which emphasizes open information sharing, transparency and ultimately the exchange of intellectual property (IP) across the stakeholders to the Government. For TALOS, the government opened the challenge to anyone who desired to participate, as long as they agreed to openly share with other participants and allowed the Government to control the IP involved. This motivated the use of open technologies and approaches.

Another characteristic is Teaming, with emphasis on Diverse Stakeholders Working Together, experts from interdisciplinary domains and skills, and often motivated to self-form teams combined of Industry and Academic participants. TALOS has well over 46 interdisciplinary teams competing in the challenge. The government utilized tele-presence and distributed collaboration environments like google hangouts to tap into experts.

Another key characteristic is having an open environment, setting the right tone and atmosphere to encourage innovation. TALOS encouraged innovation through having a Garage Demonstration Atmosphere, with an Informal Setting, and a Mindset of its "Ok to Fail in order to succeed."

Finally, agile engineering methodologies are very important for such continuous innovation. Some key ways TALOS embraced agile are:

- Storyboarding and Concept Designing
- Early Prototypes
- Continuous Integration
- Evolving Technology Baseline
- Various Levels of Technical Maturity

There are many examples in literature of organizations using challenges and competitions [4]. In this section, we provide several examples based on our personal experience of using such methods in support of key business operations in the workforce, specifically in the Government or our own organization, MITRE.

Specifically, some additional areas where extending innovation in the workforce can be helpful include:

- **Innovation**: seeking to spark new ideas to hard problems.
- **Acquisition**: seeking new ways to acquire capability.
- C**apability Assessment and Evaluation**: Assessing user experience or functional utility and readiness of products and capabilities.
- **Hiring Qualified Employees**: seeking new approaches for finding and evaluating high quality candidates, conducting interviews and hiring to build corporate talent pipelines.

The first example highlights innovation in a Government initiative to support projects seeking to spark new ideas to hard problems. Challenge.gov is a government challenge framework administered by the US General Services Administration (GSA) and based on the commercial Challengepost.com technology [13, 14]. Challenge.gov is a collection of challenge and prize competitions, all of which are run by more than 50 agencies across federal government. These include technical, scientific, ideation, and creative competitions where the U.S. government seeks innovative solutions from the public, bringing the best ideas and talent together to solve mission-centric problems. It is designed for agencies to host crowdsourcing contests that solicit ideas and concepts from the public.

Our next example of innovation is the use of Federal Summits. The summit allows Government, Industry, and Academia to discuss solutions to challenges in a domain, allowing for an information exchange of thought leaders and domain experts. These collaboration sessions aim to document the best practices and recommendations for the given challenge area from a commercial perspective, and the results will also drive academic research and curriculum. Mobile and Cloud Computing are current examples.

The following example highlights a Government project using challenges and open innovation as part of seeking new ways to acquire capabilities. Specifically, a Government Intelligence Community Sponsor is using challenge events to acquire new capabilities as part of a source selection process. By using challenge events, vendors can show that they understand and can demonstrate the capability sought by the Government. Vendors are asked to prove the technical applicability and user functionality of their solutions to fill the Government need based on the outcome of the challenges. The overall challenge itself is typically compromised of one or more events that exercise various aspects of a solution, such as an Interfaces, Usability and Security. In this example, the Government plans to use an Interface Challenge to perform a Technical Assessment of the vendor's ability to successfully integrate their solution into a Government's virtual test environment, and demonstrate their technical ability to integrate and perform necessary functionality based on the criteria established by the government. The Government will then conduct a Usability Challenge focused on evaluating a User Assessment of a vendor's ability to demonstrate their solution in the Government's virtual test environment while proving operational capability through user driven scenario based execution. The intent of the Usability Challenge is to determine if the solution is functionally relevant, performs efficiently and is aesthetically appropriate from a user perspective based on predetermined user scenarios. The use of commercial cloud services and formal usability testing methods will be used to capture user experience. The results from all events will be used to evaluate and select the new capabilities to go on contract.

An example of supporting capability assessment and evaluation is the use of challenge events by a Government Sponsor to assess user experience or functional utility and readiness of products and capabilities. Robotics Challenges (e.g. DARPA, JIEDDO, MITRE Underwater Autonomous Systems) and warfighter workshops are examples [1, 5, 8].

Finally, as an example of supporting the hiring process, we highlight MITRE's Cyber Capture the Flag (CTF) competition, a corporate initiative aimed at adopting new approaches for seeking and evaluating high quality candidates, conducting interviews and hiring to build corporate talent pipelines [15]. Using gamification as a hands-on interview will enable potential employers, especially within MITRE, to quickly identify top talent in the field of cyber security, allowing the corporation to maintain its high standards for hiring. The CTF is an annual nationwide cyber competition for high school and college students, where teams compete to solve realistic cyber problems in order to gain ranking in the game. Student performance is measured throughout the game and used as part of the evaluation process. Top teams and students win scholarships, training and intern job offers. The use of this system to hire talented, knowledgeable employees would greatly increase the Assured Computing core competency area of the organization.

5. RETROSPECTIVE

In this section, we briefly discuss our assessment of potential benefits and challenges associated with utilizing competitions and challenge events in the work environment.

The potential benefits of challenge-based initiatives in the workforce include:

- **Interdisciplinary Effects**: Creating something new by crossing boundaries, and collaborating across them.
- **Focus**: Encourages government understanding of sought capability.
- **Innovation**: Communicates need without constraining solutions.
- **Verification**: If you don't see it, you don't buy it.
- **Synergy**: Incentivizes Industry participation and engages the user community.
- **Fairness**: Levels the playing field; exposes capabilities not promises.
- **Competition**: Harnesses the energy of the challenge for procurement of solution or talent.

There are also several challenges to innovation, related to idea generation and solution development, sponsorships and funding, scalability, customer outreach, competition and timeliness. Understanding these patterns and challenges will help organizations to better prepare for considering new approaches to open innovation, and promoting a culture of awareness for creativity.

6. CONCLUSIONS

This paper presents an examination of several approaches to foster open innovation through challenges and competitions in support of key business operations in the workforce.

As we have discussed previously, Interdisciplinary sources are becoming ubiquitous. These technological trends and approaches, taken together, offer unprecedented access to information, people and even group sentiment, offering new ways to collaborate,

connect producers to consumers to investors, and ultimately to innovate.

In summary, there are several key points to consider related to the implementation of such approaches:

- Immediate access to Operator feedback could save countless engineering hours developing technically feasible but operationally invalid options
- Very quick turn visualization in near commercial products, foam, artist's drawings, 3-D graphics has been shown to accelerate communication and validation of ideas
- Open and diverse participation means no authoritative opinion – all considered
- While the rapid prototyping and collaboration events may not solve all problems, it gives the government first hand understanding of what is known and what is not known

We have seen our customers take the plunge into challenge-based procurement. In some cases such as TALOS, it makes a lot of sense since the general concept of the procurement is so complex and the solution space is widespread. Other customers have found ChBA processes to be more complex than expected. We have found that there is no "best approach" to ChBA. Ultimately, the correct course of action will be dictated by the program/project in question. It becomes an assessment of the tolerance to technical scrutiny that will have to be weighed against the need for innovative solutions.

7. REFERENCES

[15]1] MITRE Strategy for Challenge-Based Acquisition in the Government, The MITRE Corporation, http://www.mitre.org/capabilities/acquisition-effectiveness/acquisition-initiatives/challenge-based-acquisition.

[2] Cherinka, R. and J. Prezzama, *Emerging Trends, Technologies and Approaches Impacting Innovation*, International Multiconference on Engineering and Technology Innovation, IMETI 2013.

[3] Cherinka, P. Wahnish, J. Prezzama, *Fostering Partnerships between Industry and Academia to Promote STEM at the Secondary Educational Level, EEET Plenary Presentation, July 2012.*

[4] Cohen, L., *To the Point: Leverage the Power of the Collective Without Getting Lost in the Crowd*, Gartner Symposium/ITxpo presentation, 21-25 October 2012.

[5] Defense Advance Research Projects Agency (DARPA), www.darpa.mil .

[6] Griliopoulos, D., *The Madness of Crowdfunding*, Maximum PC Magazine, pp 45-51, March 2013.

[7] Howe, Jeff, Crowdsourcing, Why the Power of the Crowd is driving the Future, http://www.crowdsourcing.com/.

[8] JIEDDO Robotics Rodeo Challenge, 2012, http://www.army.mil/article/83762/Robotics_Rodeo_highlights_advances_in_life_saving_technologies/.

[9] Kickstarter Online Funding Platform, www.kickstarter.com

[10] Sloane, P., *A Guide to Open Innovation and Crowdsourcing: Advice from Leading Experts*, Kogan Page Publishing, 2012

[11] Weatherly, Richard PhD and Wydler, Virginia, Challenge Challenge -Based Acquisition: Stimulating Innovative Solutions Faster and Cheaper By Asking the Right Questions, 13 August 2012

[12] Zients, Jeffrey D., Deputy Director for Management (OMB), *Guidance on the Use of Challenges and Prizes to Promote Open Government*, 8 March 2010.

[13] US Government Challenge.gov online competition website for challenge and prize competitions, www.challenge.gov.

[14] Commercial challengepost.com online competition website for challenge and prize competitions, www.challengepost.com.

[15] MITRE Capture the Flag Competition (CTF), The MITRE Cyber Academy Website, The MITRE Corporation, 2014, www.mitrecyberacademy.org.

[16] TALOS - Tactical Assault Light Operator Suit - July 2013 Demonstration Recap, http://www.youtube.com/watch?v=ePl9TC2ySUY.

The author's affiliation with The MITRE Corporation is provided for identification purposes only, and is not intended to convey or imply MITRE's concurrence with, or support for, the positions, opinions or viewpoints expressed by the author.

Approved for Public Release; Distribution Unlimited. Case Number 14-2016.

Knowledge Integration and Inter-Disciplinary Communication in Action Research

LA-UR-14-26044

Heidi Ann HAHN, Ph. D.
Engineering Sciences Directorate, Los Alamos National Laboratory
Los Alamos, NM, 87545, USA

ABSTRACT

In a plenary talk at WMSCI 2012 entitled "Planning for Action Research: Looking at Practice through a Different Lens," this author asserted that behavioral science practitioners, often "back into" action research – they start out doing a process improvement or intervention and discover something along the way, i.e., generalizable knowledge, that seems worthwhile to share with their community of practice. It was further asserted that, had the efforts been conceived of as research from the outset, the contributions to the body of knowledge would be more robust and the utility of the projects would improve as well. This paper continues on that theme.

Action research and process improvement methods are briefly described and compared. A comparison of two Los Alamos National Laboratory engineering ethics training projects – one developed using a process improvement framework, the other using an action research framework – is put forth to provide evidence that use of a research "lens" can enhance behavioral science interventions and the knowledge that may result from them. The linkage between the Specifying Learning and Diagnosing stages of the Action Research Cycle provides one mechanism for integrating the knowledge gained into the product or process being studied and should provide a reinforcing loop that leads to continual improvement.

The collaborative relationships among researchers and the individual, group, or organization that is the subject of the improvement opportunity (the "client"), who are likely from very different backgrounds, and the interpretive epistemology that are among the hallmarks of action research also contribute to the quality of the knowledge gained. This paper closes with a discussion of how Inter-Disciplinary Communication is embedded within the action research paradigm and how this likely also enriches the knowledge gained.

Keywords: Action Research, Process Improvement, Case Methods, Engineering Ethics

1. ACTION RESEARCH AND PROCESS IMPROVEMENT METHODS

Action research, as defined by Kock [1], simultaneously improves the subject of study and generates knowledge. The action research paradigm is used in evaluating social science interventions, such as educational initiatives, organizational development efforts, and behavioral health programs, or the effectiveness of changes to systems with humans in the loop, such as human-computer systems or enterprise business systems.

The classic Action Research Cycle put forward by Gerald Susman and Roger Evered in 1978 [2] is shown in Figure 1. It comprises five stages:

- Diagnosing – identifying improvement opportunity or a general problem to be solved
- Action Planning – considering alternative courses of action to attain the improvement or solve the problem
- Action Taking – selecting and implementing a course of action
- Evaluating – studying the outcomes of the selected course of action, and
- Specifying Learning – reviewing the outcomes of the evaluation stage and building knowledge by describing the situation under study

The output of Specifying Learning may lead to additional iterations of the cycle, serving as input to a new diagnosis.

One typical process or product improvement cycle is the PDCA or Plan-Do-Check-Act cycle that was derived from W. Edwards Deming's work [3] beginning in the early 1950's. As the name implies, the PDCA quality management cycle is a four-step process:

- Plan – identify the targeted improvement and the expected output

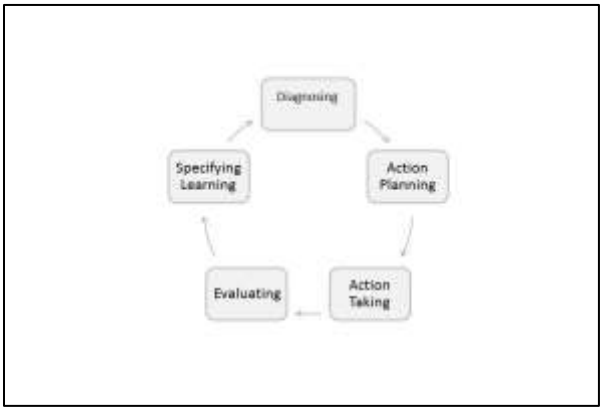


Figure 1. The Action Research Cycle [2]

- Do – implement the change and collect data needed to confirm or refute the satisfaction of the expected output
- Check – compare the actual results collected in the Do step to the expected results
- Act – analyze the causes of differences between actual and expected results

Corrective actions may be requested, leading to another iteration through the PDCA cycle. Corrective actions most often take the form of additional improvements to the product or process under study, however, it is also possible that the goal state will need to be altered based upon improved information. Figure 2 provides a representation of the PDCA cycle.

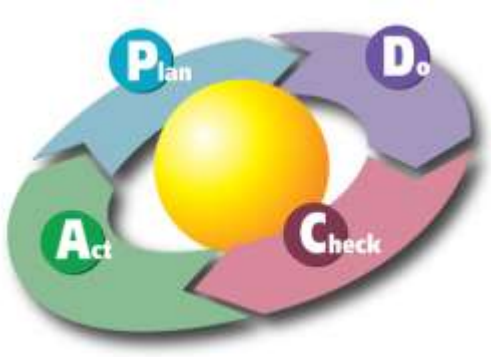


Figure 2. The PDCA Cycle[1]

2. COMPARISON OF ACTION RESEARCH AND PROCESS IMPROVEMENT METHODS

On the surface, it appears that the primary difference between action research and process improvement is the inclusion in action research of the step "Specifying Learning." And, it is true that the PDCA cycle generally limits knowledge-sharing to the enterprise rather than contributing to the generalizable body of knowledge. However, the differences are actually deeper and more subtle than that.

Although both paradigms sound a lot like the scientific method, they are epistemologically different. The PDCA cycle is built on a positivist epistemology. Positivists generally assume that reality is objectively given and can be described by measurable properties that are independent of the researcher. Positivist research is characterized by formal propositions, quantifiable measures of variables, hypothesis testing, and the drawing of inferences about a phenomenon from a sample to a stated population [4].

In contrast, action research reflects an interpretive epistemology. Interpretivists generally attempt to understand phenomena through the meanings that people assign to them. Interpretive research does not predefine dependent and independent variables, but focuses on making sense of emerging situations [5]. Generally, practice- or theory-based questions, rather than formal hypotheses, are used to guide the data collection and analysis.

This difference in perspective influences the types of data collected in the two paradigms. Generally, the data used in PDCA is quantitative and focused on attributes of the process or product. In action research, observation of participants, surveys, and interviews are the most common data collection methods. This is not to say that the methods are strictly limited to either quantitative or qualitative data. In PDCA, for example, qualitative assessments of the subjects' perceptions of the "goodness" of the process or product may also be performed. In action research, quantitative measures, such as throughput of an educational intervention, may supplement more subjective or qualitative metrics. But, the preponderance is toward quantitative data for PDCA and qualitative data for action research.

One final important difference between the two paradigms is with respect to the relationship between the researcher and the subjects of the study. A hallmark of action research is tight collaboration between the researcher and the individual, group, or organization that is the subject of the improvement opportunity (the "client"). This occurs in all steps, with the possible exception of Specifying Learning, which may be the sole responsibility of the researcher. In positivist research like PDCA, the practitioner is more likely a detached spectator, and the client is an object to study [2]; direct interaction with the subjects is usually limited or even non-existent.

3. ENGINEERING ETHICS TRAINING PROJECT OVERVIEW

In 2012, this author presented a paper [6] titled "Adapting the Case Model Approach for Delivery of Engineering Ethics Professional Development Units (PDUs)" describing how engineering ethics case studies were used to meet a need that members of the Los Alamos National Laboratory's (LANL's) workforce had to obtain professional development units for maintaining professional engineering licenses and other professional certifications.

A needs analysis conducted in accordance with the Systematic Approach to Training (SAT) [7] concluded that given the large target population (about 120) who need ethics PDUs on a biennial basis to meet New Mexico (NM) State licensing requirements and cost and logistical constraints related to LANL's remote geographical location, lack of vendor-provided training in the area, and the inability to tailor vendor-provided online training to incorporate LANL-specific requirements, in-house delivery of engineering-ethics training that could be used to fulfill PDU requirements was the preferred solution. Because of the recurring nature of the requirement and the static nature of the information (i.e., the core principles of engineering ethics are relatively constant), it was determined that workers should be exposed to an initial, in-depth training followed by annually updated refresher training (which is defined as a "short-term course aimed at recall and reinforcement of previously acquired knowledge and skills" [5]).

[1] Attribution for Figure 2: By Karn-b - Karn G. Bulsuk (http://www.bulsuk.com). Originally published at http://www.bulsuk.com/2009/02/taking-first-step-with-pdca.html (Own work) [CC-BY-SA-3.0 (www.creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons

Developed in accordance with SAT [7], the initial training covers the elements of the NM *Code of Professional Conduct – Engineering and Surveying* (NMAC); ethical obligations to the engineering profession and other professionals; and various federal legal requirements, most especially export control law, that have the potential to impact the practice of engineering at the Laboratory. It has been delivered both in classroom and online settings. Although the initial training does incorporate some case-based "test your knowledge" exercises, it is primarily a lecture- or presentation-based pedagogical model.

Unlike general ethics courses, which are fairly flexible in the content they present in any given year, the content of the engineering ethics course is relatively static – for instance, the NMAC, which changes only infrequently, must be addressed each time. While the NM state requirements could have been met by having the target audience retake the initial training each year, this would not have been very satisfactory from the learner's point of view. This is especially true in light of the literature from the field of "androgogy," or the art of teaching adults, which suggests that lectures, and especially lectures in which the same information is repeated, may not be the ideal instructional model for adult learners [8]. Therefore, as the engineering ethics refresher training was being designed, other instructional designs were considered.

Case-based instruction was the preferred pedagogical model because it was seen as best meeting the needs of adult learners, as described by Knowles, Holton, and Swanson [8]. Online delivery was preferred to enable the greatest throughput, at the learners' convenience, and with the least cost. Because there was a concern about online delivery of cases not affording the richness of classroom discussion, the online cases were initially designed with branching, which enabled learners providing incorrect responses to explore the case further or to receive feedback as to why their selected response was not the best answer.

Both the initial training and the refresher were developed using a PDCA-like paradigm – the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model from the Systematic Approach to Training [7]. As a result of using a process improvement frame, the success metrics selected were all quantitative and were aimed at answering the questions of whether the intervention had been effective at delivering PDUs to the target audience and whether the training was good at transferring the knowledge. Participants were not surveyed about the efficacy of online delivery of case studies, so it was not possible to answer questions such as whether the trainees found the case method to be pedagogically more appealing than traditional lecture-based methods, as had been theorized, or whether the branching incorporated into the instructional design was an adequate surrogate for the feedback provided via dialogue in traditional face-to-face case methods.

In a keynote address entitled "Planning for Action Research: Looking at Practice through a Different Lens" delivered at WMSCI 2012 [9], this author speculated as to what the engineering ethics training project would have looked like had an action research lens been used instead of the PDCA paradigm, stating:

- The Diagnosis would have been the same – there was a need to provide PDUs for the target audience and to refresh trainees' knowledge on engineering ethics principles as a result of their experience with the intervention
- Action Planning and Action Taking would also have been the same – the literature on adult learning and cost and logistical requirements guided the choices
- Evaluation would have been different, as explicit consideration of the pedagogical value of the intervention would have been included
- As a result, Specifying Learning would have had added value in terms of the knowledge gained over and above that obtained when using a process improvement frame of reference

Because the need for delivery of engineering ethics PDUs is ongoing, this project provided a rare opportunity for a do-over. As described in the WMSCI 2014 *Proceedings* [10], the 2012 version of the engineering ethics case studies was designed incorporating an action research perspective from the outset. Both the intervention itself and the data collection scheme were modified. A moderated discussion board was included as part of the courseware in the hope of augmenting the richness of the case experience beyond what the branching used previously could provide. Data collection included some of the more qualitative measures suggested by the action research paradigm. In addition throughput and correct response rate data, formal participant reaction regarding the effectiveness and utility of the course, the effectiveness of case studies in meeting the needs of adult learners, and the value of the discussion board were also solicited. The survey used (see Figure 3) was a modified version of Thalheimer's learner survey [11]. Unlike many "smile sheets," which ask general questions about the learning experience, this survey format asks learners to respond to specific learning points covered in the learning intervention. The learning objectives for the refresher training were used as the key learning points to survey against.

Capturing data about the *value* of individual key concepts provides more meaningful information about changes that should be made in future learning interventions [11]. In addition to addressing general ratings, the evaluation form also asks two critical questions related to how likely the concepts learned will be utilized on the job and how likely the concepts will be shared with others. This provides information regarding whether the training is likely to have an impact where it was intended.

Modifications to Thalheimer's [11] basic structure included questions related to participant preferences regarding case-based learning as compared to other instructional methods along the andragogical factors suggested by Knowles [12] and questions related to the utilization and value of asynchronous discussion augmentation of the online cases. It was hoped that this would validate the conclusion that a case-based model is the most appropriate method for delivering the educational experience to an adult target population and to gauge the effectiveness of threaded dialogue in improving the richness of the learner's experience and the quality of the feedback provided.

Impressions of the Learning Experience for the Engineering Ethics Case Study Refresher	
Value of Specific Information	
Learning Concept	**Circle ONE Number Below**
Making better decisions when faced with ethics related situations.	1. Most people already know this. 2. I already use this concept regularly. 3. Provided a nice reminder. 4. Deepened earlier understanding. 5. Concept was new to me.
Being knowledgeable regarding the Rules of Professional Conduct that apply to Professional Engineers licensed in the state of New Mexico.	1. Most people already know this. 2. I already use this concept regularly. 3. Provided a nice reminder. 4. Deepened earlier understanding. 5. Concept was new to me.
Knowing how to identify and resolve business situations requiring ethical judgment.	1. Most people already know this. 2. I already use this concept regularly. 3. Provided a nice reminder. 4. Deepened earlier understanding. 5. Concept was new to me.
Knowing where to go to get help when I am unsure about my best could of action.	1. Most people already know this. 2. I already use this concept regularly. 3. Provided a nice reminder. 4. Deepened earlier understanding. 5. Concept was new to me.
Overall Ratings	
Rate the overall value of the learning experience. *(Circle ONE number to the right. Please don't circle the words.)*	Very Little Value 1 — 2 — 3 — 4 — Very Valuable 5
Rate the likelihood that you will use what you learned within the next two weeks. *(Circle ONE percentage to the right.)*	0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Rate the likelihood that you will share what you learned with a coworker or friend within the next two weeks. *(Circle ONE percentage to the right.)*	0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Overall Comments *(Provide specific comments on any aspect of the learning experience in the space below.)*	

Figure 3. Thalheimer's Basic Learner Survey

4. DIFFERENCES IN KNOWLEDGE GAINED USING A PROCESS IMPROVEMENT FRAME OF REFERENCE VERSUS AN ACTION RESEARCH FRAME

Learnings that would not have been available had a process improvement framework continued to be used were attained in each of the following areas: value of the information imparted, likely impact of the training, the effectiveness of case models in meeting the needs of adult learners, and value of the discussion board. (Results on the quantitative measures of throughput and retention are detailed in the WMSCI 2014 Proceedings paper [10] and will not be repeated here.)

Of the 59 trainees who took the 2012 refresher, 29 completed the survey, for a response rate of 49%. Table 1 shows the results regarding the value of specific information relative to the learning objectives. The most common response across all learning objectives was that the materials "provided a nice reminder." This result is not surprising given that the case studies were intended to refresh knowledge gained through prior training. The results on the questions related to the likely impact of the training were positive – trainees generally reported a high probability that they would use what they learned in their job and that they would share what they had learned with their coworkers.

Learnings about the case method's support of adult learners are shown in Table 2. There were two adult learning principles for which the case method provided better support than presentation-based methods: the tendency toward movement from dependency upon an instructor to greater autonomy and self-directedness and the orientation toward learning as being problem-centered and contextual. The methods were viewed as equally supporting the remainder of Knowles' [12] principles by a plurality, if not a majority, of respondents. In no case was the presentation-based method of instruction viewed as best supporting the andragogical principles by a plurality of respondents. These results were somewhat surprising. It was thought that case methods would be seen as better supporting Knowles' principles related to incorporation of learners' experience bases and incorporation of the various roles that they had played in their professional lives, especially because the cases had been designed to allow the trainees to explore the cases from the point of view of involved workers, managers, and others. Comments on the case method received in response to an open-ended question were consistently positive:

TABLE 1. VALUE OF SPECIFIC INFORMATION

Learning Objective	Rating				
	Most people already know this	I already use these concepts regularly	Provided a nice reminder	Deepened earlier understanding	Concepts were new to me
Making better decisions when faced with ethics-related situations	3.6%	7.1%	57.1%	32.1%	0.0%
Being knowledgeable regarding the Rules of Professional Conduct that apply to Professional Engineers licensed in the State of New Mexico	3.4%	13.8%	41.4%	41.4%	0.0%
Knowing how to identify and resolve business situations requiring ethical judgment	3.4%	13.8%	48.3%	31.0%	3.4%
Knowing where to go to get help when I am unsure about my best course of action	0.0%	17.2%	41.4%	34.5%	6.9%

TABLE 2. RATINGS OF INSTRUCTIONAL DELIVERY METHODS

Adult Learning Instructional Design Principle	Rating		
	Most people already know this	I already use these concepts regularly	Better supported by presentation-based instruction
The need to know not only the subject matter, but also the why, what, and how underlying it	37.9%	44.8%	17.2%
The tendency toward movement from dependency upon an instructor to greater autonomy and self-directedness	58.6%	37.9%	3.4%
The need to incorporate the learner's experience base as an integral part of the instruction	37.9%	51.7%	10.3%
The orientation toward learning as being problem-centered and contextual	55.2%	37.9%	6.9%
The need to incorporate the various roles that the learners play/have played in their professional lives	41.4%	51.7%	6.9%
The basis of the learner's motivation being in the intrinsic value of the learning and personal pay-off	24.1%	69.0%	6.9%

> "The case method puts a real world perspective on the lessons and, especially when consequences of failure to behave ethically are demonstrated, it makes the lesson have meaning."

> "For this subject matter, case studies seem to be more meaningful."

The only negative comments received had to do with learners being uncomfortable with the lack of a definitively right or wrong answer for many of the scenarios:

> "Ethics can be black/white, but sometimes it is gray (or striped or polka-dotted)... these gray areas are the hardest thing for engineers to come up with the 'right answer.'"

These were consistent with comments that had been received informally in prior years, including relative to the initial presentation-based training, and served to substantiate a hypothesis that the discomfort was due to the nature of the subject matter rather than an inherent weakness in the case method, as had been postulated by the Food and Agriculture Organization of the United Nations [13].

About 20% of survey respondents reported visiting the discussion board, and 100% of those who did visit rated the experience as being of average or greater value. But, not one of those who reported visiting actually contributed – all of the comments there were planted by the instructor. Based on the number of hits on the site it is clear that some trainees did visit, but they lurked.

Figure 4 shows that changes resulting from use of the action research frame of reference were more substantive than had been anticipated. Not only did the evaluation change, going even beyond what had been predicted, but diagnosing and action planning and action taking changed as well. And the result was, in fact, that the knowledge gained in specifying learning was far more robust than had been possible previously.

5. INTERDISCIPLINARY COMMUNICATION IN THE ENGINEERING ETHICS PROJECT

One important difference between the process improvement and action research paradigms is with respect to the relationship between the researcher and the subjects of the study, with action research being characterized by tight collaboration between the researcher and the client.

The engineering ethics project affords an opportunity to illustrate the differences in communication and involvement of the subjects in generating knowledge when a process improvement framework was used versus when an action research frame was employed.

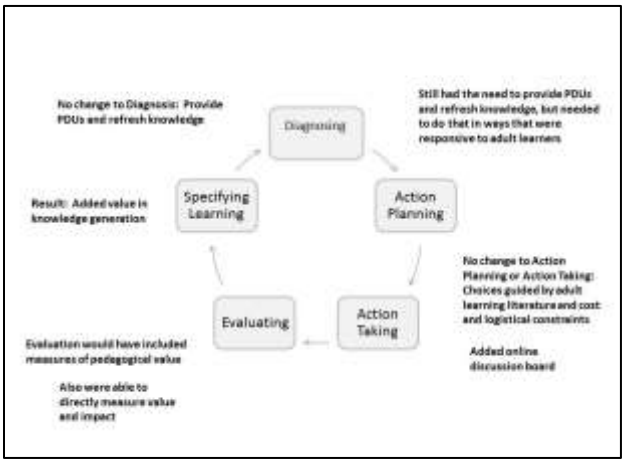


Figure 4. Changes to Engineering Ethics Intervention Resulting from Use of an Action Research Frame of Reference

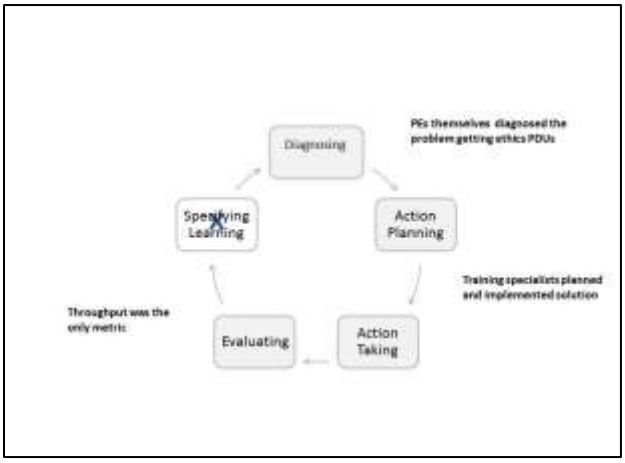


Figure 5. Communication in the Process Improvement Paradigm

As shown in Figure 5, in the process improvement case, the initial problem identification came in the form of queries from the engineers needing PDUs regarding how they could fulfill their continuing education requirements. This problem was turned over to the training specialists, who planned and implemented the initial solution – an online presentation on the NM Professional Code and various professional society and institutional policies related to ethical situations pertinent to the engineering workforce. The only metric applied was the number of people who took the course. There really was no specification of learning – the training team discussed the courseware and throughput among themselves; this led to the additional diagnosis of the need for refresher training.

The cycle was repeated again, still with communication within the training community, but without engaging the trainees. The training specialists included the need for refresher training in the diagnosis; modified the solution to include refresher training using case studies (and action that had been suggested by research into adult learning); and added a metric, correct response rate, intended to assess whether information was being retained.

That mode probably would have continued had not something else happened: The call for papers for WMSCI 2012 prompted a realization that there were learnings from the project that might be of interest to the ethics education community of practice. Engagement with a different community of practice led directly to knowledge generation that would not have happened had the researchers within the single discipline communication "cocoon."

In addition, this author was invited to present a keynote on action research at WMSCI 2012. This caused a change in thinking about the project, from using a process improvement frame to using an action research frame. That, in turn, led to a richer diagnosis as well as much greater engagement with the "subjects" of the research.

While the training specialists still had responsibility for planning and implementing the solution, the action taking phase was designed to afford the opportunity for direct engagement with the learners through a discussion board.

The evaluation phase was the area most affected by adoption of an action research paradigm. Learners were directly involved in evaluating the value and impact of the intervention as well as the degree to which the case method meets the needs of adult learners.

The inclusion of the learners' perspective added to the knowledge generated in a way that had not been possible using the observational methods employed under the process improvement paradigm. The information about the value, impact, and effectiveness of the case models is more robust than throughput and response rate data could provide. In addition, new knowledge was obtained about the efficacy of case models vis a vis other methods in meeting adult learners' needs. This is shown graphically as Figure 6.

As stated previously, there was, however, a void in the knowledge gained when it came to the efficacy of the discussion

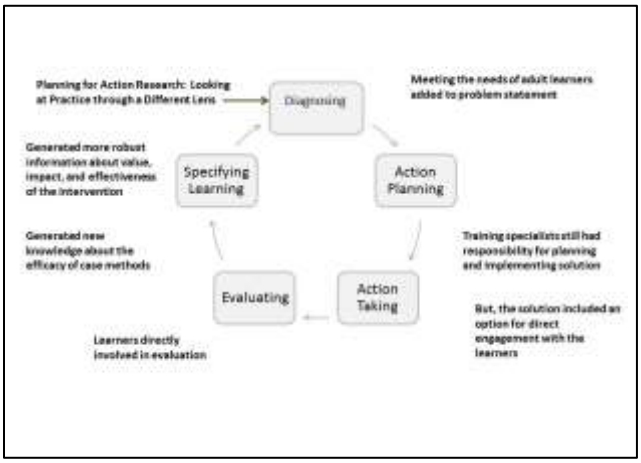


Figure 6. Communication in an Action Research Frame

board. Recall that there had been a concern from the start of the project that online delivery of the case studies would not provide the richness of experience afforded by the opportunity for dialogue in a classroom setting. The idea of using branching to allow further exploration of the cases was the first solution to this "problem," then an online discussion board to facilitate direct engagement among the community of learners was added. The plan was to evaluate the quantity and quality of posts and to ask learners about the value of the discussion board. When no learner posts materialized, the only evaluation method was learners' perceptions of the value of the discussion board, which gave contradictory results when perception and behavior were compared, as was described previously.

The root of the problem most likely resides in the absence of inter-disciplinary communication regarding this aspect of the "problem." In this case, the training specialists were back to talking among themselves. The question of whether the online delivery of cases suffered from a lack of richness was never formally included in the problem statement, nor was consideration of what effect branching might have had on mitigating the problem if there was one! Feedback from the learners on this topic could have provided invaluable knowledge that might have influenced the trainers' instructional design decisions.

To summarize the communication patterns in the two paradigms, as Figure 7 shows, when all of the communication occurred within the Training Community of Practice, it was possible to solve the problem that had been identified – getting the engineers PDUs and refreshing their learning annually. Research into pedagogical models and assessment of their fit with the characteristics of adult learners generated learnings worthy of contribution to the generalizable body of knowledge.

Interactions with the Action Research Community of Practice led to a whole new approach, influencing the Training Community of Practice, in particular with regard to how the intervention was evaluated. This, in turn, led directly to the trainers' engagement with the Community of Learners, which generated additional knowledge about the suitability of case

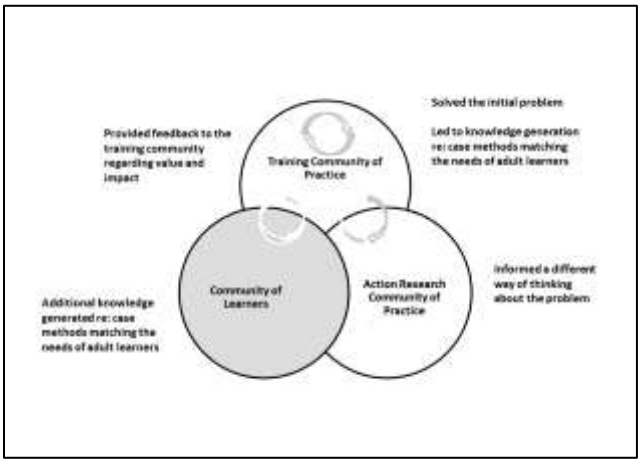


Figure 7. Interdisciplinary Communication in Action Research

methods for meeting the needs of adult learners, and provided feedback to the Training Community regarding the value and impact of the intervention.

5. CONCLUSIONS

In this paper, convincing evidence has been provided indicating that looking through the lens of action research when planning social science interventions or process improvement initiatives can both enhance the effectiveness of the initiative and improve the value of the resulting contributions to the practitioner community's body of knowledge. Greater knowledge is gained through action research than is typically attained using traditional PDCA methods. The knowledge can then be incorporated within the Action Research Cycle to improve the intervention under study.

The interpretivist frame of reference that is characteristic of action research causes inter-disciplinary communication to be embedded into action research projects, by encouraging interaction between the researchers and their subjects as well as between the discipline-specific communities of practice associated with the subject of the intervention and the action research community itself. Inter-disciplinary communication, too, contributes to enriching the knowledge gained.

And so, for the LANL engineering ethics training project, the cycle continues. In the WMSCI 2014 *Proceedings* paper [10], it was noted that consideration was being given to actions to incentivize trainees to contribute to the discussion board – such as offering additional PDUs for substantive participation. As a result of renewed interaction with the Action Research Community of Practice, that idea has been rethought. Instead, the trainers will engage with the learners to understand whether there actually is a problem with the richness of the online case experience; the likely effectiveness of mitigations, including branching and the discussion board, in addressing the problem if it exists; and to understand the dynamic involved in learners placing value on the discussion board but not actively participating in it, before making any additional modifications to the intervention.

6. REFERENCES

[1] Kock, N. Action Research: Its Nature and Relationship to Human-Computer Interaction. In Soegaard , M. and Dam, R. F. (Eds.). **Encyclopedia of Human-Computer Interaction.** Aarhus, Denmark : The Interaction-Design.org Foundation, 2011.

[2] Susman, G. and Evered, R. An Assessment of the Scientific Merits of Action Research. **Administrative Science Quarterly**, Vol. 23 (4), Ithaca, NY : Cornell University, 1978, pp. 582-603.

[3] Deming, W. E. **Out of the Crisis**. Cambridge, MA : Massachusetts Institute of Technology, 1982.

[4] Orlikowski, W. J. and Baroudi, J. J. Studying Information Technology in Organizations: Research Approaches and Assumptions. **Information Systems Research**, Vol. 2, 1991, pp. 1-28.

[5] Kaplan, B. and Maxwell, J. A. Qualitative Research Methods for Evaluating Computer Information Systems. In Anderson, J. G. , Aydin, C. E. and Jay, S. J. (Eds.). **Evaluating Health Care Information Systems: Methods and Applications**. Thousand Oaks, CA : Sage, 1994.

[6] Hahn, H. A. Adapting the Case Model Approach for Delivery of Engineering Ethics Professional Development Units. **Proceedings of the 16th World Multi-Conference on Systemics, Cybernetics, and Informatics**, Orlando, FL, 2012, pp. 231-237.

[7] I. L. Goldstein. **Training: Program Development and Evaluation.** Monterey, CA: Brooks/Cole Publishing Company, 1974.

[8] Knowles, M. S., Holton III, E. F., and Swanson, R. A. **The Adult Learner: The Definitive Classic in Adult Education and Human Resource Development.** Boston, MA: Elsevier, 2011.

[9] H. A. Hahn, "Planning for Action Research: Looking at Practice through a Different Lens." Invited Keynote Plenary presented at the **16th World Multi-Conference on Systemics, Cybernetics and Informatics**, Orlando, FL, 2012.

[10] H. A. Hahn, "Effectiveness and Utility of a Case-Based Model for Delivering Engineering Ethics Professional Development Units," in **Proceedings of the 18th World Multi-Conference on Systemics, Cybernetics and Informatics**, Orlando, FL, 2014.

[11] Thalheimer, W. **New Design for My Smile Sheet. Will at Work Learning.** [Online] July 9, 2008. [Cited: April 27, 2009.] http://www.willatworklearning.com/2008/07/smile-sheets-th.html.

[12] Knowles, M. S. **The Adult Learner: a Neglected Species.** Houston, TX; Gulf Publishing Company, 1973.

[13] Natural Resources Management and Environmental Department (of the Food and Agriculture Organization), **Management of Agricultural Research: A Training Manual. Appendix 2: The Case Method.** [Online] 1997. [Cited: April 9, 2012.] http://www.fao.org/docrep/W7500E/w7500e0b.htm.

C-ITS as multidisciplinary area with high demand on telecommunications solutions

Tomas ZELINKA,
Faculty of Transportation Sciences, Czech Technical University of Prague
110 00 Praha 1, Czech Republic

ABSTRACT

Cooperative Intelligent Transport Systems (C-ITS) are concentrated on transportation systems with goal to improve usability, efficiency and safety of the existing as well as newly constructed transportation infrastructure. These concepts are associated with high society expectations that C-ITS will principally participate in resolving of continuously growing transportation challenges. C-ITS represents typical multidisciplinary area where effective cooperation of wide range of different disciplines is the key condition of the success. Possible approach to treatment of requirements on telecommunication services in C-ITS applications is presented.

Keywords: ITS, C-ITS, VANET, ETC, telematics, performance indicator, multidisciplinary

1. INTRODUCTION

Transport systems in their complexity represent typical multidisciplinary area. Both design as well as operation of transportations systems cannot be any more based only on the traditional civil engineering, but these activities integrated branches like vehicles engineering as well as wide range of information technologies. Legal, sociological, psychological and safety understanding as well as ubiquitous financial aspect must be taken into considerations, as well. Action based on mix of these disciplines must be extremely carefully and efficiently managed to reach required result.

Expectations of transportation infrastructure clients use to be, at least in critical hours, much above available capacities and situation in most populated areas typically differs only in proportion of time transport infrastructure capacity is partially or totally collapsed. Number of active clients, i.e. vehicles, continuously grows as well as proportion of congested transportation networks.

There are two principle approaches how to reduce this trend:

- To expand transport infrastructure capacity by investment into transportation infrastructure – i.e. to build new capacities as well as to expand physical capacities of the existing streets, roads, highways etc.
- To improve existing infrastructure usage efficiency – approach based on ITS/C-ITS

Extensive approach has limits not only in restricted financial resources, but frequently also in reduced or no realistic possibilities of further infrastructure development. In many urban areas there is not available additional space to add any new infrastructure. In such cases the only potential can be identified in existing transportation infrastructure usage intensification and Intelligent Transport Services/Systems (ITS) are associated with expectations that ITS/C-ITS will significantly support society afford to resolve growing transportation challenges.

Setting of relevant mix of mentioned approaches can be very painful process thanks to specific investors and other decision makers strategies, even though close cooperation between those two streams is for sure the best alternative.

Transport systems management has got wide range of tools. Some of them directly influence traffic flow, some of them are based on user's restrictions and motivations like Electronic Toll Collection (ETC) variable charging. Decision on regulation mix must take into account that transport systems are principally influenced by human being acting e.g. as vehicles drivers and psychological, sociological as well as financial factors must be adopted in evaluation processes, as well.

2. COMMUNICATIONS SOLUTION FOR C-ITS

2.1 C-ITS and communications schemes

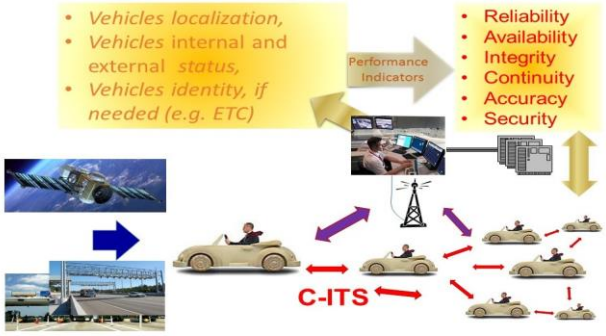


Figure 1. C-ITS background

Fig. 1 introduce simplified background of the C-ITS traffic management model. Road authority collects information about subjects localization, their internal and external status, and, if required, also about their identity. Data quality is quantified by performance indicators. Definitions of these system parameters – performance indicators - were developed in frame of the ITS architecture – see e.g. [1] - [3]. Localization is available via roads gentries or via GNSS services available still with limited, but step by step improving, quality and reliability. Communication between authorities and subjects on the road, i.e. Vehicle to Infrastructure communication (V2I), belongs to more or less standard ITS tools. New dimension in ITS, i.e. communication between subjects – Vehicle to Vehicle (V2V) - principally broadens possibilities of the ITS system to the cooperative approach (C-ITS). Any subject can share relevant information with any other subject in the served area.

Substantial part of the telematics performance analysis represents decomposition of the system into individual sub-systems of the chain. System decomposition enables application of the telematic chains follow-up analysis according to the various criteria.

Quantification of requirements on relevant telecommunication solutions in the telematic chains plays one of the key roles in this process. Mobility of the telecommunication solution represents one of the crucial system requirements namely in context of very specific demand on availability and security of

the solution. Communications performance indicators quantify telecommunications service quality – see e.g. in [1] - [3].
Impact of the telecommunications services on the telematics system performance is described by the transformation matrix *TM*. One of possible *TM* identification approaches is described in [4] or [7].
Requirements on latency of telecommunications solution depend on type of application:

- Direct/indirect traffic management requires typically response time of the whole chain in minutes and minutes fractions,
- Post-crash car autonomous systems like European e-Call system expect action within seconds and
- Pre-crash passive/active safety tools require total reaction time in sub-seconds. For active safety systems 100ms in total was accepted as the limit value.

Fig. 2 presents different data communication alternatives. Vehicle to Vehicle (V2V) communication in combination with communication Vehicle to Infrastructure provided on two levels (local/global) can support whole range of required functions. Base station antenna positioned outside of picture intends to stress, that this function is not provided as a part of the ITS service and that such services relay on publically provided mobile services.

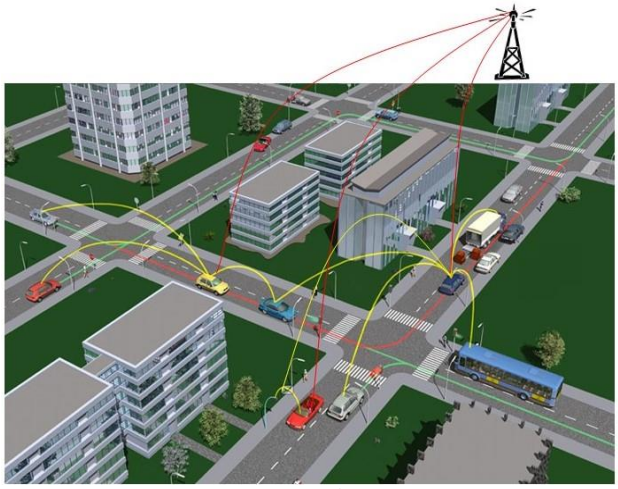


Figure 2. Tree levels of communication

Fig. 3 and Fig. 4 facilitate two telecommunication solutions generating different number of hops and relevant delays contributed to the overall service latency. Fig. 4 emphases communication scheme simplification and minimization of the final service latency.

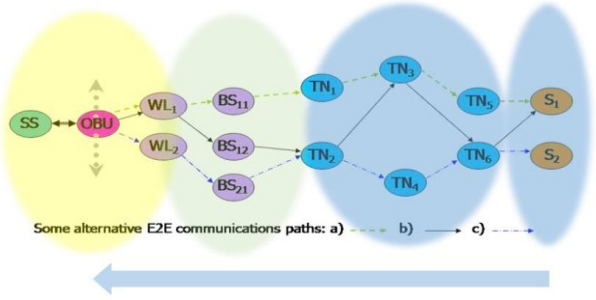


Figure 3. V2I communication architecture

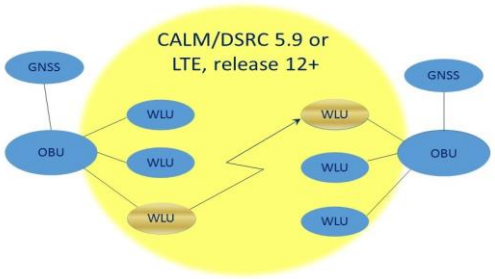


Figure 4. V2V communication

2.2 VANET

Vehicle Ad hock Network (VANET) is special case of Ad hock networking. VANETs are designed to support C-ITS applications with specific requirement on solutions:

- Constrained mobility,
- Highly dynamic topology,
- Frequent connects/disconnects,
- Extremely high security requirements.

High mutual speed of communicating vehicles can essentially reduce capacity of the shared communication system to fraction of nominal capacity. Newly designed routing protocols based on continuously identified network topology (each vehicle is equipped with GNSS unit) can support communication issue much more effectively, and, specifically vehicle grouping in carefully set clusters can remarkably reduce impact of this phenomena, as well.

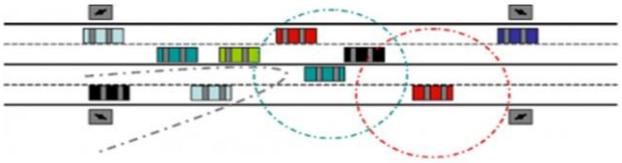


Figure 5. Clustering

3. MULTI-PATH ACCESS SOLUTION PRINCIPLES

Family of standards CEN TC204, WG16.1 "Communications Air-interface for Long and Medium range" (CALM) represents widely conceived concept of selection and switching to the best available wireless access alternative in given time and area. Substitution process of existing path by the alternative wireless access solution is understood as the second generation of the handover principles. CALM applies IPv6 protocol which allows to continuously remotely trace active applied alternative. Handover in CALM is accomplished on the L2 of the TCP (UDP)/IP model. Alternative approach based on standard IEEE 802.21 "leads" to the "general handover" using L2 switching as well, even though its system approach remarkably differs from that proposed by CALM.
Decision on handover action is based on evaluation of selected performance parameters. Bit Error Rate (BER), Packets Lost Ratio (PLR) or packet Round Trip Delay (RTD) are typical but not the only possible performance indicators used for decision processes.
Switching to the alternative path is accepted as relevant solution if active alternative is unable to resolve performance limits. Handover action, however, can be also evoked by identification of more suitable alternative to the active one. Reason for handover action can be identified e.g. in case of alternative service appearance where more suitable cost conditions are

offered even though existing alternative is technically acceptable as sufficient.
Handover decision processes represent basis for the efficient adaptability of the telecommunications wireless service. Solutions based on Policy-based Management (PBM) can be mostly identified and this concept has been traditionally applied in the IP based networking. This approach can be combined with Model Driven Architecture (MDA) approach. For example POETRY service creation framework applies such combination of PBM method and MDA model.
Alternative approach is based on application of Bayes statistics [11]. Set of measured parameters is extended by static parameters like service cost, corporate policy factors etc. Self-trained classification processes enables identification of the best possible selection. Classification algorithm is trained by time line of training data linked with correct assignment to the relevant class, i.e. selected path.
CALM standards represent extraordinary basis for future implementations and in combination with advanced decision processes there can be expected availability of effective ITS telecommunication solutions. These rigorously defined principles will most probably initiate some changes in approaches to the architecture of telecommunications solutions and potential of massive implementations so might represent good investment challenges.

However, no massive action to date have been noticed and some activities have been already redirected to the alternative principles based e.g. on standards IEEE 802.21 and not only to it.

4. Available Data Services Performance

Some ITS implementation identified significant problems with performance of GSM data services. We studied mobile data services performance in precisely defined laboratory conditions and presented results can be understood as the best possible reached values. Nevertheless, continuous afford in technology innovations enables step by step improvement of these presented limits.

4.1. GPRS

Fig. 6 shows in red average round trip delay (RTD) and in green packet loss ratio (PLR). GPRS technologies can be applicable only for applications where latency and high potential of packet losses are not critical.

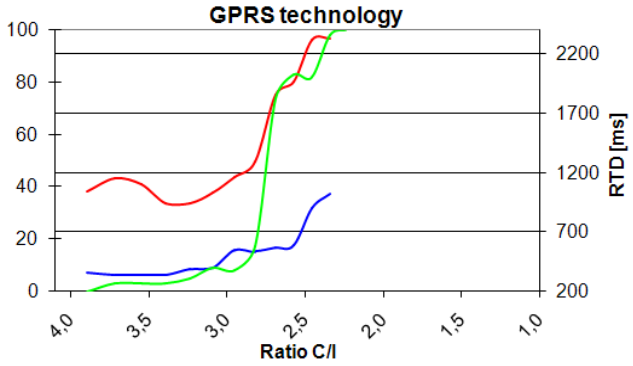


Figure 6. PLR and RTD - GPRS technology

4.2. EDGE measurement results

From Fig. 7 it is clear that due to improvement in average RTD (red) EDGE technology has got wider but still limited applicability in C-ITS solutions than GPRS.

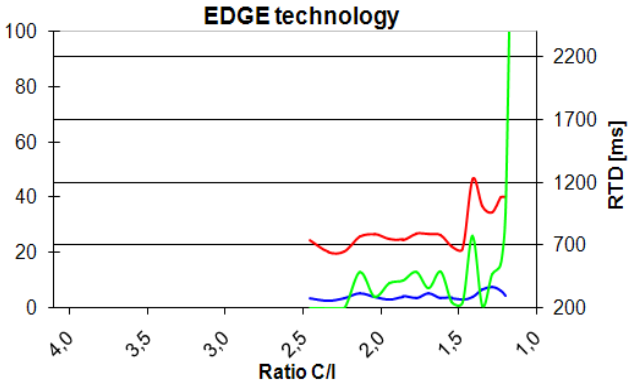


Figure 7. PLR and RTD - EDGE technology

4.3. UMTS measurement results

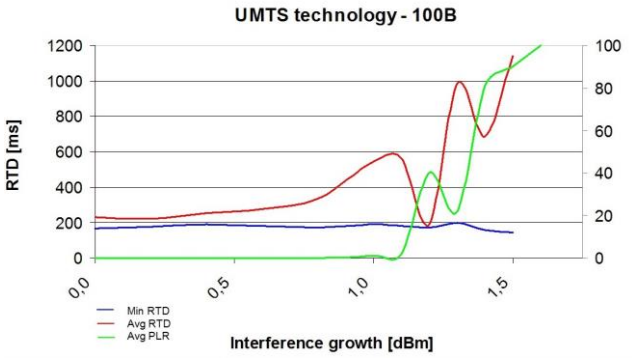


Figure 8 . Basic UMTS technology

UMTS is even more reasonable for usage in ITS applications if compared with EDGE, however, average RTD is still above expectations of proactive C-ITS applications.

4.4. WiMax services performance

Technology based on IEEE 802.16d/e/m standards known as (Mobile) WiMax represented in time of introduction one of the most promising substitutions for ITS. Basic results of WiMax measurement in situ are in Table 1.

Table 1. – obtained parameters of the WiMax access

Site	Visibility	RTD [ms]	SNR [db]
1	LOS	45.6	33
2	LOS	47.1	32
3	NLOS	44.6	-26
4	NLOS	44.8	-27

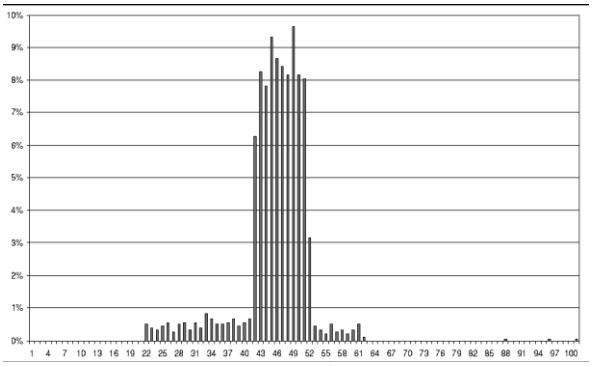


Figure 9. RTD spectra of LOS - SNR =+33db

RTD presents "Round Trip Delay" in ms, SNR is "Signal to Noise Ratio" in dB, and LOS represents "Line Of Sight" and NLOS "Non LOS". RTD results are displayed on Figure 9 and 10. We can identify that displayed RTD represents in average approx. 45ms and that it is one order faster than the GSM technologies (GPSR, EDGE). It is important to stress that average RTD is practically independent on radio conditions (SNR).

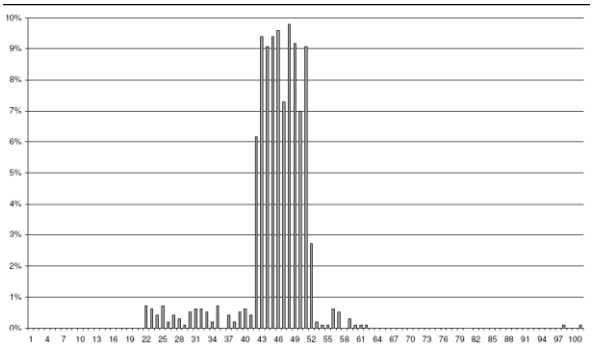


Figure 10. RTD spectra of NLOS - SNR=-27db

This technology implementations are much behind expectations, even though namely mobile version of this standard IEEE 802.16e/m might be acceptable for wide range of C-ITS. Most probably in key parameters comparable and potentially widely already on market available LTE based services demotivated ITS designers to apply this promising WiMax mobile technology.

4.5. WiFi DATA SERVICES PERFORMANCE

WiFi (IEEE 802.11) technology belongs to typical telecommunications „surprises". Due to massive penetration as the low end wireless access solution WiFi technology has been positioned as cheap product of the mass market. While in single user regime is latency in milliseconds, due to standardly applied CSMA/CA access protocol in multiuser regime latency depends on the cannel load, and in case of heavy load it can easily reach hundreds of milliseconds.

However, IEEE 802.11 standardization group has been step by step extending standard in direction which is welcomed by ITS applications.

For example Amendment IEEE 802.11e added tools for Quality of Service (QoS) management, i.e. important tool for sensitive on service latency applications.

Amendment IEEE 802.11p is locked to standard IEEE 1609 known as WAVE (Wireless Access for the Vehicular Environment) or DSRC (Dedicated Short Range Communications) 5.9. IEEE 802.11p acts as the MAC layer of IEEE 1609 standard. This Amendment supports remarkable extension in supporting mobile telematic applications. Solutions based on 802.11p enable both C2C and C2I with mutual speed tolerance up to 240 km/h.

Even though basic conditions for this standard application were already reached there must be resolved issue that IEEE 802.11p has got in conflict with European system DSRC 5.8GHz in their electromagnetic in-compatibility. This issue remains still as the hot topic for ISO/CEN and ETCI.

5. SOLUTION FOR C-ITS DATA SERVICES

5.1. DSRC 5.9/WAVE

Standard IEEE 1609 known as DSRC 5.9 or WAVE treat communication structure, security mechanisms, and high-speed short-range wireless communication.

Standard is designed for specific dynamic transportations environment and its parameters are specifically tuned to requirements of ITS/C-ITS in summary:

- Both C2 I& C2C,
- IEEE 802.11p based Physical and MAC layer,
- Range up to 1000 meters,
- Velocity tolerance up to 240 km/h,
- Data rate - up to 27 Mbps,
- QoS management,
- Low latency (milliseconds) for single communication – total latency in VANET (below 100ms for 100 cars communicating in VANET),
- Strong security support provided (IEEE 1609.2),
- Based on off-the-shelf chip set & software with reasonable influence on OBU price.

However, to reach guaranteed telecommunications service parameters radio-base stations should be installed approx. in 1km distance in all around supported road network. Question is, if there is strong enough society demand backed with relevant resources to justify installation and operation of such base stations network on all roads and highways.

5.2. BEYOND 3G STANDARDS

LTE (Long Term Evolution) is well designed solution for public services providers and it is understood as the basis of the next generation of mobile networks. Significant similarity of LTE with most of principles adopted with WiMax can be identified as very positive fact. Before 4G parameters are reached in implemented systems "beyond 3rd" generation category was adopted to stress fundamentally new approach to mobile services. This technology offers flexibility of the network configuration and high services availability. LTE successfully attacks mass market with promises of high transmission capacity and very low latency. Well supported QoS management tools are very important parameter for ITS systems. Interoperability with GSM, WCDMA/HSPA, TD-SCDMA and CDMA is resolved, as well.

ITU-R M.2134 defined 4G with following set of parameters included (both LTE and 802.16m were accepted as relevant alternatives for implementation):

- Mobility up to 350 km/h (guaranteed is connection),
- 1Gbps for low mobility users,
- 100 Mbps for mobile users,
- Latency for data below 10ms,
- Handover interruption max. 27.5ms (intra-frequency).

4G can is implementable as WiMAX (IEEE 802.16m) or 3GPP LTE-A (release 10 or higher). 3GPP release 12 should include between others also support of terminal to terminal single hop communication and both V2V and V2I communications could be supported in this case.

C-ITS applications requirements on guaranteed QoS are strict, and, there are serious doubt if mobile services providers will be ready to accept such type of business.

6. CONCLUSION

C-ITS represents new phenomena in modern transportations systems solutions. There are strong society expectations that C-ITS will help in improvement of transportation conditions with direct impact on quality of life. Telecommunication support is definitely one of necessary conditions C-ITS can appear as widely and massively accepted solutions.

Promising telecommunications alternative solutions were presented and even though each of them has got strong technological potential, none of them have clear future potential to win it. In telecommunications history we have been faced with both positive and negative discrepancies between expectations and reality. As examples can be presented telecommunications phenomena like IP, Ethernet or VoIP. There is strong tendency to explain their unexpected growths or fails as evolution processes and incompetence to predict their future has been accepted as status quo.

Alternative approach could profit from understanding of these processes as the multidisciplinary area. Technical disciplines should be combined with wide range of "soft" disciplines including those being able to qualify impacts like the ones related with the key market players decisions. We believe that approach based on multidisciplinary understanding of related processes can lead to much more efficient and better predictable processes enabling better concentration on the principle goals.

REFERENCES

[1] M. Svitek, **Architecture of ITS Systems and Services in the Czech Republic**, International Conference Smart Moving 2005, Birmingham 2005, England.

[2] M. Svitek, T. Zelinka, T., **Communications Solutions for ITS Telematic Subsystems**, WSEAS Transactions on Business and Economics, Issue 4 (2006), Vol. 3, pp 361 – 367, Athens 2006, ISSN 1109-9526,

[3] M. Svitek, **Dynamical Systems with Reduced Dimensionality**, Neural Network World edition, II ASCR and CTU FTS, Praha 2006, ISBN:80-903298-6-1, EAN: 978-80-903298-6-7.

[4] T. Zelinka, M. Svitek, **Communication solution for Vehicles Navigation on the Airport territory**, Proceedings of the 2007 IEEE Intelligent Vehicle Symposium, Istanbul, Turkey, pp 528–534, IEEE Catalogue number 07TH8947, ISBN 1-4244-1068-1.

[5] M. Svitek, T. Zelinka, **Communications Environment for Telematic Subsystems**, Proceedings of 11-th World Multi-Conference on Systemic, Cybernetics and Informatics, Volume II, pp 362-367, IIIS/IFSR, Orlando, FL, USA, ISBN-10: 1-934272-16-7, ISBN-13: 978-1-934272-16-9

[6] K. Yang, J. Wittgreffe, M. Azmoodeh: **Policy-Based Model-Driven Creation of Adaptive Services in Wireless Environments,** IEEE Vehicular technology Magazine, September 2007, pp. 14-20.

[7] T. Zelinka, M. Svitek: **Communication Scheme of Airport Over-ground Traffic Navigation System**. ISCIT 2007. IEEE Sydney, 2007, pp 329 - 334. IEEE Catalogue No. 07EX1682(C), ISBN 1-4244-977-2, Library of Congress 2007920360.

[8] M. Svitek, T. Zelinka: **Communications multi-path access decision scheme.** Neural Network World, ICS AS CR and CTU, FTS, Praha, No. 6. 2008, pp 3 - 14, 2008, ISSN 1210 0552

[9] T. Zelinka, M. Svitek, **Multi-path communications access decision scheme,** WMSCI, Volume III, pp 3233-237, IIIS/IFSR, Orlando, FL, USA, ISBN-10: 1-934272-32-7, ISBN-13: 978-1-934272-33-6.

[10] T. Zelinka, M. Svitek: **Adaptive Wireless Access Environment in Transport Solutions**, WMSCI, Volume IV, pp 310 - 315, IIIS/IFSR, Orlando, FL, ISBN 978-1-934272-62-6.

[11] T. Zelinka, M. Svitek, T. Starek, Z. Lokaj: **Adaptive Wireless Multipath Access Solution for Transport Telematics.** International Journal of Computers and Communications, Issue 1, Volume 5, 2011, pp 9 – 17, ISSN: 2074-1294

[12] T. Zelinka, Z. Lokaj, M. Srotyr: **Service Quality Management in the ITS Telecommunications Systems**. Journal of Systemic, Cybernetics and Informatics, Orlando, FL, 2013, Vol. 11, No. 8, pp 29-36, ISSN: 1690-4524

Forging Industry-Academic Alliances

Joseph M. Woodside
Department of Decision and Information Sciences, Stetson University
DeLand, FL 32723, US

ABSTRACT

With ever increasing amounts of data, organizations are identifying the importance of Business Intelligence (BI) and Analytics for decision making. However in order to realize the full potential of these technologies, organizations require well-trained and educated management and analytic subject matter experts to transform the data and results into actionable information for decisions.

In order to meet this demand for analytical talent, a Center for Business Intelligence and Analytics (CBIA) housed within the university seeks to develop knowledge and skills vital in the fast changing field of business, through developing the next generation of managers and analysts with skills in decision-making through use of analytical techniques. This presentation provides the strategic framework for the definition and development of a CBIA and framework for joint academic and industry collaboration to develop the next generation of industry experts. The core components including industry demand, alliance objectives including objectives, curriculum and talent requirements, and opportunities.

Keywords: Center, Data, Business Intelligence, Analytics, Industry-Academic Alliance

1. INDUSTRY DEMAND

With ever increasing amounts of data, organizations are identifying the importance of Business Intelligence (BI) for decision making. Gartner recognized BI as one of the fastest growing areas despite minimal economic growth, as organizations seek to compete and differentiate themselves through data based decisions. However in order to realize the full potential of BI technologies, organizations require well-trained management and analytic subject matter experts to transform the data and results into actionable information for decisions. A McKinsey Global Institute report identified requirements for 1.5 million additional analytic staff, with a shortfall due to knowledge gaps within the current workforce. In another SAS survey nearly three quarters of organizations indicated an investment priority of improving analytical skills of current employees, with more than half indicating a priority of hiring more analytical talent [1,2,3,4,5]

The Center for Business Intelligence and Analytics (CBIA) seeks to develop knowledge and skills vital in the fast changing field of business administration, through developing the next generation of business managers and analysts with skills in decision-making through use of analytical techniques. This document provides the strategic framework for the definition and development of a CBIA, and operate in collaboration with existing departments and schools at the university and partner universities, along with the multi-disciplinary framework for joint academic and industry collaboration to develop the next generation of BI industry experts. The CBIA can then be utilized to drive university growth and take advantage of increased sector growth over the next several decades [6,7]

The CBIA consists of two main components, the knowledge center and research center. The knowledge center consists of operational aspects such as curriculum and skills development: program and project management, technical support, training, data stewardship, analytics, data mining, performance management, data acquisition, and delivery. The second component, the research center seeks to develop publication quality research and development. This includes establishing the participating members as leaders in research and development, gaining industry exposure through peer review outlets, incorporating empirical methodology for educational modules, and improving understanding of theoretical backgrounds and implications. The knowledge and research center components work closely together to provide feedback on current practices, identify future trends and opportunities, and improve overall CBIA value [6,7].

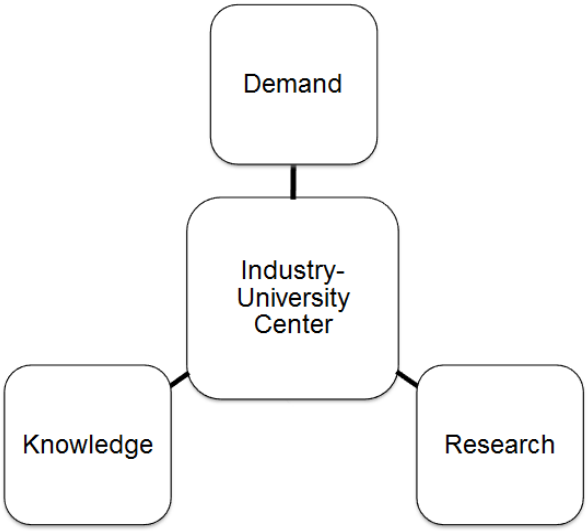


Figure 1. Industry-University Structure

2. INDUSTRY-ACADEMIC ALLIANCES

Industry organizations recognize universities for their rich talent pool of enthusiastic students and expert faculty, with the universities recognize business organizations as a source of real-world problems and commercialization. The center alliance allows organizations to source research and join together with a university to develop competitive advantages, provide input for curriculum and research focus, and drive

innovation. Table 1 displays a list of aligned objectives from an industry and academic perspective. Applied curriculum and talent requirements are also described in further detail [8].

Table 1. Industry-Academic Alliance Objectives

Academic	**Industry**
Partnerships	Partnerships
Broaden Student Experience	Broaden Employee Experience
Broaden Faculty Experience	Source Outside Subject Matter Expertise
Grants Support	Economic Development
Employment Opportunities	Access to Trained Labor Pool
Placement	Secure Top Talent
Curriculum Development	Applied Industry Training
Educational Events	Continuous Learning
Interesting Problems and Innovation	Intellectual Property

Applied Curriculum

A key component of the center is establishing formal curriculum programs through best practices established in industry and research, in order to prepare students for future contributions and career paths. The curriculum is centered around a core curriculum consisting of business intelligence, business analytics, information systems, and multi-disciplinary concentration courses with areas including: Accounting, Finance, Computer Science, Management, Sports, Economics, Marketing, and Healthcare. For example a technology student can take marketing electives to broaden their marketing background, or similarly a marketing student can take computer science to expand their technical background. This allows the capability to expand curriculum tracks while maximizing use of existing programs.

Examples of program and curriculum enhancements include adding a career component and resume development to introductory courses, adding certificate programs to courses, such as those offered by the International Institute of Business Analysis [9], including simulations on mobile devices, and applied course projects. The certificate is available to student that successfully complete the course and core competencies related to the professional setting. The course projects are also linked to business opportunities or problems, such that the students are involved in a real-world exercise application and the organization benefits from the project output. The overall criteria guiding the curriculum consists of five components and is also shown in figure 1, these include: analytical thinking, application of ethical principles, understanding business principles, evaluating business globally, and communicating effectively.

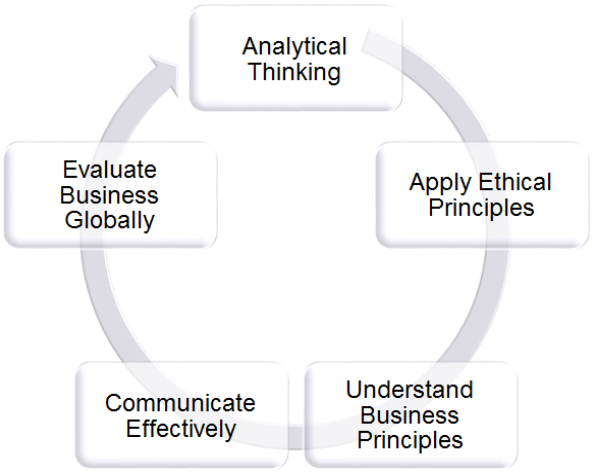


Figure 2. Program and Curriculum Criteria

Talent Requirements

Talent is considered a key requirement of the center output and success. In order to prepare industry-ready professionals a blend of analytics and domain knowledge, skills, and abilities are included to provide the necessary learning foundation. Domain knowledge would include the specific area or field that someone may specialize in, and where the analytical skills may be applied. Healthcare Analytics would be one example of a specialty where students would require analytics training though also be knowledgeable of healthcare terminology and the industry to improve their opportunity for a successful career in their chosen field.

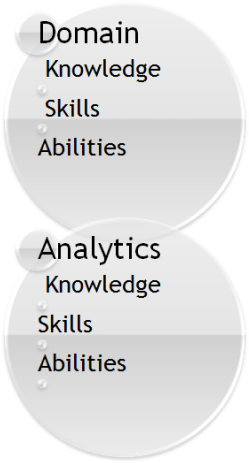


Figure 3. Domain and Analytics Intersection

3. OPPORTUNITIES

The center opportunities are organized around a set of four pillars or 4 P's including: Programs, Projects, Placement, and Partnerships. These are available at varying timeframe commitments and consist of several components as shown in Table 2.

Table 2. Industry-Academic Opportunities

Pillar	Timeframe	Components
Programs	Daily+	Educational Workshops Speaker Series
Projects	Monthly+	Funded/Joint Research Experiential Coursework
Placement	Quarterly+	Internships Employment
Partnerships	Annual +	Advisory Board Joint Research

4. CONCLUSION

Industry-Academic Alliances are increasingly important in the competitive marketplace. Both organizations and universities must leverage these relationships to gain respective value. The components for objectives, applied curriculum, and talent requirements are outlined to provide the framework for developing a joint industry-academic center and maximize the advantage of the resulting opportunities available.

5. REFERENCES

[1] Gartner, "Gartner Forecasts Global Business Intelligence Market to Grow 9.7 Percent in 2011", **Gartner**, 2011.

[2] TechJournal, "Data analytics, business intel huge job growth opportunity", **TechJournal**, 2011.

[3] TechJournal, "Investment-in-business-analytics-and-talent-will-rise-in-2012", **TechJournal**, 2011.

[4] McKinsey & Company, "Big data: The next frontier for competition", **McKinsey & Company**, 2014.

[5] SAS, "Getting Your Money's Worth with Analytics", **SAS**, 2012.

[6] J.M. Woodside, "Business Intelligence and Learning, Drivers of Quality and Competitive Performance", **Cleveland State University**, 2012.

[7] J.M. Woodside and T. Surynt, "Best Practices for Building a Center for Business Intelligence and Analytics", **Academy of Business Disciplines**, 2013.

[8] G. Edmondson, et al, "Making Industry-University Partnerships Work", **Science|Business Innovation Board**, 2012.

[9] IIBA, "Academic Certificate in Business Analysis", **International Institute of Business Analysis**, 2014.

Academic Ethos, Pathos, and Logos

RESEARCH ETHOS

Nagib CALLAOS

Simón Bolívar University and
The International Institute of Informatics and Cybernetics (IIIS, www.iiis.org)

ABSTRACT

Elsewhere (N. Callaos and B. Callaos, 2014)[1] we have shown the conceptual necessity and the pragmatic importance of including Ethos, Pathos, and Logos in any systemic methodology for Information Systems Development (including software-based systems) and for the design and implementation of informing processes. This is the first article of a planned series in which we will try to apply what has been shown and concluded in the mentioned article to the specific case of Academic Informing or Academic Information Systems. Research activities include informing processes, which should address the respective Ethos. Our purpose in this article is to address one of the issues involved in this aspect. With this article we are trying to make a step forward according to the recommendations we included in the conclusions of the referred article (N. Callaos and B. Callaos, 2014). To do so, we will briefly abridge previous work, provide some facts via real life examples, give few opinions and ask many questions. Few of these questions will be rhetorical ones while most of them will be oriented to generate reflections regarding the respective issue and potentially some research, intellectual enquiry, or practice based position papers.

GENERAL CONTEXT

It is evident that effective communication is a necessary condition for Academic Informing. This effectiveness has been basically related to academic writing, pedagogical innovations, and educational technologies, mostly in the context of disciplinary logic and rigor. Persuasiveness in academic writing has been admitted for a long time as necessary condition for effective academic communication and informing. That academic writing is, or should be, *persuasive* is not news. Ken Hyland affirms that "It dates back at least as far Aristotle and *it is widely accepted by academics themselves*."[2] This includes scientific communication. An increasing number of articles and books have been published lately regarding the importance of persuasiveness in scientific communications and on the Rhetoric of Science.[3] But, the focus has been, up to the present, on academic writing. Our academic and professional experience show that persuasiveness is, or should be, implicitly or explicitly, an essential characteristic in all academic activities: research, education, and consulting or problem solving, and not just in academic writing. Experience-based reflections show that a more comprehensive and systemic approach is required for enhancing the effectiveness of Academic Informing in its societal and civic contexts. A main purpose of the articles series, mentioned above, is to examine and reflect on a more comprehensive approach to Academic Informing for a higher effectiveness of these activities. This will be attempted from a *pragmatic-teleological* perspective, i.e. oriented by the ***ends*** of Academic Informing and by the potential ***means*** that might be used to achieve these ends. We will focus in applying classical means which have effectively been applied in the past but they are not being applied (at least not explicitly) in the last few decades to support academic informing. Consequently, we will examine the relationships between academic activities and persuasive processes or methodologies, focusing mostly on *Academic Ethos, Pathos, and Logos*, as fundamental and necessary characteristics of more persuasive academic informing and, hence, more effective academic activities.

[1] This article is based on previous articles and on practice-based reflections as well as on Action-Research and Action-Learning in the context Methodological Action-Design.

[2] Italics added

[3] See for example Alan G. Gross, 1996, 2006, and H. W. Simon (Ed.), 1990.

SPECIFIC CONTEXT

A main source of the mentioned series of articles, and of this first one, will be our about 45 years of academic and professional activities. This will be a main input to applying a mostly *Reflexive Methodology*,[4] regarding the issue described above. Part of this practice-based reflections and conclusions was the article mentioned above which mostly represent a product of our professional experience in the context of Information Systems and Informing Processes analysis, design, and implementation.

In the mentioned article, we basically applied what Donald Schön (1983) proposed, in "The "*Reflective Practitioner*" in the context of our professional Practice. Now we will try to apply it in the context of our academic activities. Our aim in this paper is to make a short presentation of the main reflections and conclusions we have had during our academic practice in research-oriented informing activities (including peer review, conferences organization, journal editing, research administration, etc.). Educations and consulting will be addressed in following articles, and mentioned in this article when they have relationships with the main topic here.

INTELLECTUAL AND PRAGMATIC IMPORTANCE OF ACADEMIC ETHOS, PATHOS, AND LOGOS

In this section we will address the intellectual and pragmatic importance of Academic Ethos, Pathos, and Logos. Next articles will go in more details regarding this issue. Let us her provide a very brief discussion on this issue which objective is to provide Intellectual and Pragmatic context for following sections.

We have been for a long time explicitly and frequently emphasizing in our classes, to our students and colleagues, in both Higher Education and Industrial contexts, that the very well known Medieval Trivium is not being adequately applied Higher Education[5], or not applied at all in some Higher Education organizations. We noticed this educational gap while teaching Information Systems (to students in Computer Engineering) and practicing in the area of Information Systems Engineering, for about 35 years simultaneously in both cases. We have discussed at length (including conferences presentations and publications[6]) during these 35 years that *Computing and Software Engineering are **necessary** conditions for the development of computing-based information systems, tailored to the specific needs and requirements of a specific organization or sub-organization*. *But, they certainly are not **sufficient** conditions for the professional effectiveness in developing this kind of information systems*. Computer or software engineers need to adequately communicate with machines, but they also need to have the skills for effective communication with human beings (the users) for adequately eliciting the respective requirements, designing an adequate system, training the users for an effective use of the system, and maintaining the system especially when new requirements emerge as a consequence of the dynamics, uncertainties, and changes in which the organizations are always immersed in. This means that the system analyst/synthesist needs to communicate with both computers via ***artificial languages*** and the users via ***natural languages***. He/She also need to make adequate translation between both languages. Otherwise, there will be a high probability of failure no matter how good he/she is as computer or software engineer or computer scientist. Skills in natural languages and effective communication are what the Medieval Trivium is about. This is why we included a detailed exploration regarding this issue in our detailed work regarding a "Systemic Systems Methodology" (N. Callaos, 1995) which might contain local *systematic* parts but it is a *systemic* one as a hole.

As a communicational process, academic informing effectiveness depends, at least, on the adequacy of the communicational means used; which, in turn, depends on the comprehensiveness of the possible/feasible means, as well as on the potential synergies and emergent properties that might be generated in their simultaneous design and implementation. In order the increase the probability of being comprehensive, it might be advisable to

[4] See for, example, M. Alvesson and K. Sköldberg, 2001, 2009; and K. Etherington, 2004.

[5] See, for example, Callaos N. and Callaos B., 2014, pp. 21-25; and N. Callaos, 1995, pp. 527-534 for the case of Systems Engineering and Computing Engineering.

[6] In Callaos and Callaos, 2014, we integrated and resumed what we presented in many conferences, written in many publications, and emphasized in many academic and industrial courses.

explore the product of many years of reflection regarding the essence of human communication and the means suggested as necessary for its effectiveness. Our experience shows us that *the classical means are far from being obsoletes, though they require being adapted to the present objectives of academic informing as well as to the new communicational technologies, tools, and methodologies.*

Beside *comprehensiveness*, a systemic approach would require an adequate *contextualization* of what is being examined. Since Academic Informing is an essential part of academic activities, it should be examined from the perspective of its general context of academic activities which include academic thinking, academic behaving, academic caring, academic valuing, etc. besides academic informing. Consequently, we will be referring mostly to academic activities and in some specific situations to academic informing and to the relationships that exist, or should exist, between academic informing and other academic activities.

NINE AREAS THAT SHOULD BE ADDRESSED

With regard to a comprehensive study, we suggest that the traditional triad of Ethos (character, integrity, credibility), Pathos (emotion, feelings), and Logos (logic, language) are applicable and/or are being (implicitly or explicitly) applied and/or should be applied in academic activities each of the three main academic activities: research, education, and consulting or real life problem solving. Each one of these three academic activities requires:

A. Convincing by means of the *character, integrity, and credibility* of the academic as author, educator and/or consultant.

B. Persuading colleagues, students, and/or clients by also appealing to *emotions* of both the communicating academic and receiver of the message intended to be communicated.

C. Persuading colleagues, students, and/or clients by the use of *reasoning*, *logical arguments*, and an effective use of the communication languages (technical an natural) being used

This might be framed in the context of a 3x3 matrix, i.e. Ethos, Pathos, and Logos as related to each of the three basic academic activities, i.e. Research, Education, and Consulting or Real Life Problem Solving. With this framework we can relate/integrate the three academic activities and the three persuading means, among each other and between activities and means. Consequently, nine specific areas should be addressed. If we add to these areas the relationships among them and the second level of *Meta-Ethics*, *Meta-Pathos*, and *Meta-Logos*, then we can notice that there are many analytical areas that might be addressed in a comprehensive analysis. This is why we are thinking about a series of articles; which, as a set, might address the most important aspects of this issue.

On the other hand, if we accept that, 1) the three academic activities should be ***integrated*** for the potential generation of synergies and beneficial emergent properties, and 2) the classical triad of Ethos, Pathos, and Logos are related to each other[7] and integrated in human intellectual activities, then it is easy to imagine that all 9 kinds (matrix 3x3) of academic ends/means would be, or should be thought as, integrated in a synergic whole, which synergy would be greater than integrating academic activities according to just one of triadic elements of Ethos, Pathos, and Logos.

Having provided a brief description of the general context, the specific context, and a an initial analysis, which should precede to a necessary integration of the parts produced by the analysis, our purpose in what follows is to focus in one very important (we would say vital) aspect of Research Ethos (i.e. one of the nine fundamental issues presented above); while pointing to the relationships it has (or might have) with the other analytical ingredients mentioned above.

RESEARCH ETHOS

An important, probably a ***necessary condition*** in research activities is to adequately communicate the

[7] In N. Callaos and B. Callaos, 2014 we have shown that the relationships among Ethos, Pathos, and Logos are actually, or potentially might be, of a cybernetic nature, including potential co-regulative loops (via reciprocal negative feedback and feedforward) and co-amplificatory loops (via reciprocal positive feedback)

results of these activities. Consequently, Ethos, Pathos, and Logos are required for this kind of communication. Even so, an increasing number of research communication are lacking of the respective Ethos, Pathos, or Logos. Many scientific or engineering communications lack even the three of them. Let us present some recent (and less recent) much known examples.

1. The International Weekly Journal of Science ***Nature*** reported on February 25th, 2014 that "***Publishers withdraw more than 120 gibberish papers."*** Richard Van Noorden[8] (2014) affirmed that "Conference proceedings removed from subscription databases after scientist reveals that they were computer-generated…The publishers Springer and IEEE are removing more than 120 papers from their subscription services after a French researcher discovered that the works were computer-generated nonsense… Ruth Francis, UK head of communications at Springer, says that the company has contacted editors, and is trying to contact authors, about the issues surrounding the articles that are coming down. The relevant conference proceedings were peer reviewed, she confirms — making it more mystifying that the papers were accepted."

   Consequently, many questions arise:

   - ***Did the Publishers have Scientific Misconduct or Unethical Behavior?*** No, they did not, in our opinion. Publishers like IEEE and Elsevier would not do it because it makes no sense at all. The amount of money involved is extremely negligible as compared with their annual revenue and they would never risk their prestigious image and high credibility level. This is just a pragmatic reasoning. There are many other reasons, especially related to their history and the great service they provided, for a long time, to be credible channels for scientific communications via publications of papers.

   - ***Did the respective Editor-in-Chief have Scientific Misconduct or Unethical Behavior?*** Not necessarily, in our opinion, because for similar reasons, it would make no sense.

   - ***The conference Organizers?*** Not necessarily in our opinion, because reputable journals with high scientific prestige and reputable editors also had the same kind of ethical problems, and pragmatic concerns. We will present one example later.

   - ***The authors?*** In this specific case, our opinion is an almost a certainty that authors have had unethical behavior and academic or scientific misconduct. But, authors has not always had this kind of misconduct because there have been several intentional hoaxes that have been submitted in order to announce them later. We will see some of these cases below.

   - ***The reviewers of these papers? The Peer Reviewing Methodology Applied?*** Very probably in our opinion and according to our experience, this is the case. In a survey of members of the Scientific Research Society **"only 8% agreed that 'peer review work well as it is'."** (Chubin and Hackett, 1990, p. 192) Is the essence of the scientific publications quality assurance highly ineffective? Is the whole academic promotional system based on something that just the 8% think is working? Is it ethical to continue "measuring" the research performance of academic with a toll that just the 8% believe it is effective? ***Is this ethical?*** How many scholars are really concerned about this issue? *Is there any consensus about what the notion of "peer" means?* How many concerned scholars, conference organizers, editors, or publishers are trying to find a solution to this paradoxical problem?

[8] Richard Van Noorden "has reported for *Nature* in London since 2009, after spending two years as a reporter at *Chemistry World*. He has a master's degree in natural sciences from the University of Cambridge." (*Nature*, doi:10.1038/nature.2014.14763)

While one of the authors of this article was Dean of Research and Development of a university, we had the experience of trying to identify, during two years, a consensual meaning, or definition, of an internal "peer" in the university, and it was not possible. The more we tried to generate a consensus regarding this issue, among the university's professors, the more controversial became what the term means or should mean. Paradoxically, in the same university, external "peer" generated an immediate consensus, i.e. the (***unknown***) peers of a "prestigious" journal, and the level of prestige of the journal was associated with its impact factor. *Isn't paradoxical that there was no way to define a "peer" associated to the professors of the university, but it was "evident" who are peers, as long as they were professors from other universities, who are* ***unknown*** *and selected by* ***unknown*** *editors.* Later, we found out, after a literature search, that the notions related to these terms have not been sufficiently addressed. We tried to find in the literature short description of the meaning of "peer" and "peer reviewing" in order to elicit from scholars some intellectual feedback, but the attempt was unsuccessful. Consequently, we proceeded to write very short descriptions of the notion of "peer" and "peer reviewing" (Callaos, 2005). Our intention, in keeping these descriptions short, was (and still is) to ask for small amount of time from the reader in order to increase the readership potential and, hence, the probability of generating comments as well as awareness regarding this issue

- ***Is anyone else, implicitly and/or unknowingly, having ethical issues, beside those mentioned above?*** Should some chairs of academic departments consider the Academic Ethos (and probably the Pathos and Logos) related to the fact that only 8% of the members of the Scientific Research Society agreed that 'peer review work well as it is'? Should they try to identify a consensus among the professors of their departments regarding the meaning of "peer" and/or "peer review"? In such a case should they publish these meanings in order to clarify it to the faculty members of their department? Should they continue delegating the ingredients of their decisions regarding the promotions of their faculties in the hand of unknown reviewers selected by not necessarily well known editors?

2. On July 13, 2014, in an op-ed of the *Wall Street Journal*, Hank Campbell (2014), founder of Science 2:0 web site, in an article titled "***The Corruption of Peer Review Is Harming Scientific Credibility,***" informed that the reputable SAGE Publications retracted 60 articles implicated in a peer review ring at the *Journal of Vibration and Control*. This peer review ring involved assumed and fabricated identities which were used to manipulate the online SAGE submission and reviewing system. Previously The Guardian reported this news with the title "***Academic journal retracts articles over 'peer review ring' with bogus scholars***." (Jon Swaine, 2014) Steven T. Physics Today reported this fact, on July 11, 2014, with the title "***Peer-review fraud cited in retraction of 60 academic papers.****"* Corneliussen (2014), *a media analyst for the American Institute of Physics,* referring on other publications, affirms that "the penalties for scientific fraud are generally insufficient, with too little repayment of misused funding, with too little professional ostracism of offenders, and with resignations forced—and criminal charges filed—too rarely." This means (in our opinion) that ***meta-ethical*** issues have to be considered besides the ethical ones; i.e. peer reviewing methodologies should have to include ways, methods (a systemic methodology?[9]) of enforcing ethical behavior in science, and the Scientific Enterprise should also include stronger and more explicit rules and policies with regards to scientific misconduct and unethical behavior; i.e. it should be more involved and concerned at the ***meta-ethical level***. In a recent comprehensive study DuBois, Anderson, and Chibnall (2013), with the aim of

[9] See for example (Callaos and Callaos, 2014)

determining the frequency and kinds of wrongdoing at ***leading research institutions***[10] in the United States," concluded with the following terms:

> "Wrongdoing in research is relatively common with nearly all research-intensive institutions confronting cases over the past 2 years. Only 13% of respondents indicated that a case involved termination, despite the fact that more than 50% of the cases reported by RIOs [research integrity officers] involved FFP [falsification, fabrication, or plagiarism]. This means that ***most investigators who engage in wrongdoing, even serious wrongdoing, continue to conduct research at their institutions***."[11]

This clearly shows that even leading research institutions are requiring addressing both the meta-ethical and ethical levels in research. Actually, in our opinion, the academic promotional policies are contributing in the generation of unethical activities in both research and education. An academic who is unethical in the publications of his/her research the more unethical might be in his/her activities in education. In this case there are at least two generating causes of academic misconduct: a) a promotional system oriented to research production that frequently undermines the educational activities of the academic, and b) educational misconduct is usually less visible than research publications.

Consequently, it seems evident that the Scientific Enterprise, and specially leading research institutions (especially leading research universities), should urgently and carefully review both the ethical and the meta-ethical issues related to research, education, and consulting. In our opinion, the *Academic Ethos should be examined not in isolation, but along with 1) its relations with the Academic Pathos, i.e. the kind of emotions which generation should be addressed and promoted in order to increase the probability of ethical behavior and 2) its meta-ethical rules, policies, enforcement, and behavior.* To have a promotional system based essentially (and sometimes exclusively) in research production ***metrics*** (number of publications, citation index, journal impact, etc.) may be making more harm than good. Metrics are ***means***, and as such should never be confused with the ***ends*** or (which is worst) taken as ***ends in themselves***. *The later is one of the powerful sources of corruption, including both the conscious and the unconscious ones.* Should an academic department's chair reduce assessments of the research performance of the professors of his/her departments to an accounting exercise based on metrics produced by other institutions? Should departmental evaluation be reduced to the results of other organizations which decide the reviewing methodology which is usually, in turn, based on the evaluations and comments of ***unknown*** peer-reviewers chosen according the traditional double-blind reviewing methodologie? Why Ph.D. dissertations have explicitly ***known*** reviewers (the Ph.D. committee's members) who sign the respective thesis while just anonymous reviewers are who recommend to accept or to refuse the publication of a given article? *Shouldn't peer reviewing methodologies be based on non-anonymous reviewers or on both anonymous (double-blind) and non-anonymous reviewers?* In trying to answer this question we proposed, and have been working with (since 2006) a two-tier reviewing methodology which include both anonymous (double-blind) and non-anonymous reviewers. In our methodology, both reviewing processes should end up recommending the acceptance of a paper in order to generate and editorial decision regarding the acceptance of the article for its publication as a peer-reviewed article. Publication recommendation in each tier is a ***necessary*** condition but not a ***sufficient*** one for acceptance for presentation and/or publication. Recommendations from both tiers are required. We think that with this methodology we are making ***an initial step in addressing the meta-ethical level*** of the reviewing/publication processes. More details (but in a short description) can be found at (Callaos, 2006). More details in a larger article can be found at (Callaos, 2011)

3. On April 11, 2012 Carl Zimmer, in an article in the New Work Time, entitled "*A Sharp Rise in Retractions Prompts Calls for Reform*"

[10] Italics and emphasis added.
[11] Italics and emphasis added.

addressed the issue of ***the exponentially increasing number of retractions in scientific journals in the last 10 years***. Zimmer based his article on an unsettling discovery made by Dr. Fang, who is editor in chief of the journal Infection and Immunity regarding the increasing number of retractions. Simmer reports that Dr. Fang, who is a professor at the University of Washington School of Medicine, affirmed regarding the increasing number of retractions that "[n]o body had noticed the whole thing was rotten … a symptom of a dysfunctional scientific climate." Zimmer reports that Dr. Fang looked, with a fellow editor at the journal, Dr. Arturo Casadevall, "at the rate of retractions in 17 journals from 2001 to 2010 and compared it with the journals' 'impact factor,' a score based on how often their papers are cited by scientists. ***The higher a journal's impact factor, the two editors found, the higher its retraction rate***."[12] Consequently, if we were to measure the ***quality*** of a journal by the number of retractions has had, the journal with high impact (which articles are the most cited) would have lesser quality than those journals with lower impact. Does that make any sense? Should the quality of a journal be measured just with its impact factor? Should the impact factor be defined just as the number of average citations per article? Should there be other accepted definitions or metrics of journals' quality or "impact factor"? *Isn't an ethical issue to answer, or at least to try to answer, this kind of questions?*

4. The most preoccupying aspect of the retraction rate is its explosive increase in the last 10 years. Richard Van Noorden (2011) reports, in an article published by Nature (International Weekly Journal of Science), that "In the past decade, the number of retraction notices has shot up 10-fold [1000%], even as the literature has expanded by only 44%." The exponential growth is shown in the figure included in the Van Noorden's (2011) article, as well as in figure 1a of Brembs et al.'s (2013) article entitled "*Deep impact: unintended consequences of journal rank.*" Brembs et al. (2013) also shows (in figure 1D of their article) *the exponential relationships between the retraction index and the impact factor of the retracting journal*: the more the impact factor, the exponentially more the retracting index. Consequently, among their conclusions, Brembs et al. (2013) conclude that

> "There are thus several converging lines of evidence which indicate that publications in high ranking journals are not only more likely to be fraudulent than articles in lower ranking journals, but also more likely to present discoveries which are less reliable (i.e., are inflated, or cannot subsequently be replicated). Some of the sociological mechanisms behind these correlations have been documented, such as pressure to publish (preferably positive results in high-ranking journals), leading to the potential for ***decreased ethical standards.***[13] (Anderson et al., 2007)"

Shi V. Liu (2006) showed that "the percentage of retraction of the above four top journals among all retractions are on the rising trend, from 1.42% in the1980s to 6.96% in the 1990s and to 9.18% in the first 6 years of 2000s" Based on a search in PubMed on May 6, 2006, Liu (2006) listed 47 journals. The top of them according to their respective impact factors (Science, Nature, PNAS, and Cell) had 38, 32, 32, and 13 retractions respectively. All 47 journals had 309 retractions. This means that the 0.085% of the journals (the top four) had the 37.22% of all retractions. This is astonishing! 0.085% of the journals (the ones with the highest impact factors) are generating the 37.22% of the retractions.

Liu (2006) resumed his article, published in ***Scientific Ethics*** 1(2), pp. 91-93, in the abstract, as follows:

> "Top journals often use the highly exaggerated and even flawed values of the impact factors to boost their circulations among readers and increase their attractions to authors. This commercial strategy apparently worked very well because many scientific administrators have now used the place (journals) of publication as a criterion for evaluating the value of the publication. However, from a historical and objective

[12] Italics and emphasis added.

[13] Italics and emphasis added.

> perspective, top journals' high-profile publications often stand low in comparing with those truly groundbreaking and thus not "trendy" papers in the then "cold" or even ignored fields. More ironically, many such truly great papers were initially rejected by the top journals. In contrast, many "hot" and "trendy" papers published by top journals actually ended up with "spectacular" retractions. Thus, while top journals emphasize their impact factors they should realize that their impacts are double-sided. They should also confess to the world that they are also the world leaders in publishing retractions." (Liu, 2006, p. 91)

Peter A. Lawrence (2008) resumes his paper entitled "*Lost in publication: how measurement harms science*"

> "Measurement of scientific productivity is difficult. The measures used (impact factor of the journal, citations to the paper being measured) are ***crude***. But these measures are now so universally adopted that they determine most things that matter: tenure or unemployment, a postdoctoral grant or none, success or failure. As a result, ***scientists have been forced to downgrade their primary aim from making discoveries to publishing as many papers as possible***— and trying to work them into high impact factor journals. Consequently, scientific behaviour has become distorted and the utility, quality and objectivity of articles have deteriorated. Changes to the way scientists are assessed are urgently needed, and I suggest some here."[14] (Lawrence, 2008, Abstract, p. 9)

The two abstract mentioned above are just examples of an increasing number of articles in which researchers, scholars, and editors are increasingly questioning the validity of the metrics being used, as unique indicators of the quality of academic articles. ***Is it ethical to continue using metrics that increase the probability of unethical behavior in scientific research? Is it ethical to use metrics that are distorting scientific behavior?*** **Is it ethical to force scientists "*to downgrade their primary aim from making discoveries to publishing as many papers as possible*"? *Doesn't this distortion represent intellectual and/or academic corruption?*** Shouldn't we (at least try to) identify other ways of evaluating the quality of scientific publications? Isn't that an ethical, or meta-ethical, requirement? An increasing number of scientists, editors, academic administrators, and science managers (e.g. Brembs et al., 2013; Anderson et al., 2007) are at least trying to find ways of assessing scientific quality where established means and metrics are not being taken as end in itself. More research is required in this area if we are going to at least try to address both the ethical and the meta-ethical levels of scientific or scholarly research.

5. In June 15, 2009 the academics and scientists were disconcerted when they learned about a reputable journal accepting (after reviewing) and publishing an article which content was randomly generated. Nature published the news with the title "***Editor will quit over hoax paper: Computer-generated manuscript accepted for publication in open-access journal***." In this article, Natasha Gilbert (2009) reports that "[t]he fake, computer-generated manuscript was submitted to The Open Information Science Journal [Bentham Science Publishing] by Philip Davis, a graduate student in communication sciences at Cornell University in Ithaca, New York, and Kent Anderson, executive director of international business and product development at The New England Journal of Medicine. They produced the paper using software that generates grammatically correct but nonsensical text, and submitted the manuscript under pseudonyms." Bambang Parmanto, who is an information scientist at the University of Pittsburgh, Pennsylvania, and was the editor-in-chief of The Open Information Science Journal, declared to Nature (according to Gilbert, 2009) "I think this is a breach of policy … I will definitely resign. Normally I see everything that comes through. I don't know why I did not see this. I at least need to see the reviewer's comments." Parmanto claims that the Bentham published the article without his knowledge, and the director of publications at Bentham Science Publishing defended Bentham's peer review process, saying (according to Gilbert, 2009), "a rigorous peer review process takes place for all

[14] Italics and emphasis added.

articles that are submitted to us for publication. Our standard policy is that at least two positive comments are required from the referees before an article is accepted for publication." In this particular case, "the paper was reviewed by more than one person". In our opinion, this is another example of traditional peer reviewing failure. What is astonishing is that for several decades many editors, authors, and studies concluded that the traditional double-blind peer review's failures are overwhelming[15], but not much has been done 1) to substitute it by other methods for quality assessment of scientific research articles, or at least 2) to improve it via complementing it with other reviewing methods. This is a really perplexing issue. Traditional peer review is abysmally failing and the Scientific Enterprise is still based on it. Traditional peer review ***is astonishingly ineffective*** and (as we said above) ***only 8% of Scientific Research Society's agreed that 'peer review work well as it is',*** (Chubin and Hackett, 1990, p. 192). ***It is ineffective and it is perceived as ineffective by scientists but it is still untouched and untouchable by the academic world. Is it an Academic Totem?***

Is it ethical for academics, scientists, researchers, engineers, professionals, academic administrators, etc. to continue ignoring this perplexing issue? Is it ethical to force the new generations of scientists and academics to accept that their career depends on a clearly failed quality assessment tools for valuing the merit of their research? Is it ethical not to, at least, ask these questions? Is it ethical not to, at least, ***try*** *to solve this paradoxical situation or to ameliorate its effect while a solution is identified?*

6. Even reputable journals with high prestige and high impact factor that charge readers for their content (via subscriptions) may be prone to accepting nonsense and gibberish papers which are randomly computer-generated. Peter Aldhous (2007), for example, reported in *New Scientist* (owned by the publishing giant Reed-Elsevier) that graduate students at Sharif University in Iran got a randomly computer-generated paper accepted by "*Applied Mathematics and Computation*," which is a journal with a very high reputation published by Elsevier (part of Reed-Elsevier, the publishing giant that owns *New Scientist* in which this news was also reported). Aldhous (2007) reports that "[a]fter the spoof was revealed, the pre-publication version of the paper was removed from Elsevier's *Science Direct* website." The proof-correcting queries sent to the hoaxers by Elsevier can be found at http://pdos.csail.mit.edu/scigen/sharif_query.pdf . The removal of the paper after being published is at www.sciencedirect.com/science/article/pii/S0096300307003359. Aldhous (2007), also reports that "Melvin Scott, a retired mathematician based in Ocean Isle Beach, North Carolina, who serves as editor-in-chief of *Applied Mathematics and Computation*, says that the paper was accepted by an editor who has since left the journal. "I've revamped the editorial board significantly," he adds.

   It is evident, in our opinion, that the publisher did not have an unethical behavior. It is also highly probable that the editor-in-chief did not have unethical behavior either. Very probably it was the editor and/or the reviewers of the paper who behaved unethically. *It is also very probably that the reviewing methodology failed in its scientific quality assessment, especially because it very probably did not include the* ***meta-ethical dimension****, i.e. 1) a procedure or a method for the identification unethical behavior from the authors, the reviewers and/or the editors, or 2) a methodological ingredient for* ***enforcing ethical behavior****, or for minimizing the probability of scientific misconduct.*

7. Another example, which shows other aspects of the problem at hand, the acceptance of an article we did for WMSCI 2005. This article was accepted for *presentation* as a ***non-reviewed***[16]

[15] We reported on many of these conclusions made by editors, authors, and specific studies regarding the ineffectiveness of traditional peer review in Callaos, 2011, *Peer Reviewing: Weaknesses and Proposed Solutions* at https://www.academia.edu/4437207/Peer_Reviewing_Weaknesses_and_Proposed_Solutions

[16] A copy of the acceptance letter sent to the corresponding author is shown as Appendix B of the document at http://iiis.org/contents/With_Regards_to_the_bogus_pape

one and its acceptance was based on the CVs of the authors. The acceptance letter clearly said so, and the authors were informed that the paper might be accepted later as a ***reviewed*** one as soon as its reviewing process is finished. The conference's web site said clearly that about 15% of the submitted articles might be accepted as non-reviewed. The related article happened to be a randomly computer-generated one. This news was published in many outlets without informing about the whole truth, i.e. the article was accepted as a non-reviewed one and the conference web site informed up-front that about 15% of the articles will be accepted as non-reviewed. Is it ethical to present part of the truth and to take it completely out of its context? Many well intentioned academics repeated what they read in the web without any confirmation of what they read and what they are saying. Is this academically ethical? The WMSCI 2005 web page (saved in Web.Archive at http://web.archive.org/web/20070209005022/http://www.iiisci.org/sci2005/website/Papers_acceptance.asp) informed very clearly the following:

> Acceptance decisions related to the submitted papers will be based on their respective content review and/or on the respective author's CV. Invited papers will not be reviewed and their acceptance decision will be based on the topic and the respective author's CV.
>
> If the reviewers selected for reviewing a given paper do not make their respective reviews before the papers acceptance deadline, the selection committee may accept the paper as a non-reviewed paper.
>
> If a paper does not meet the criteria for inclusion as reviewed paper, the selection committee may invite the author to present it as a non-reviewed paper.
>
> Each accepted paper (reviewed and non-reviewed) is candidate for being a best paper of its respective session and, consequently, it is candidate for a second reviewing process to be made by the reviewers of the Journal of Systemics, Cybernetics and Informatics (JSCI), by means of which the best 10%-20% of the papers presented at the conference will be selected and published in the JSCI after doing possible modifications (in content/format) and extensions as to adequate them to a journal publication.

Many academics rushed to judgment before reading this text and continued with a false narrative based on part of the truth and taken completely out of its context. Is that academically ethical? Journalistically it is not ethical and journalists stopped the story after interviewed us and after reading the text above. Shouldn't academics follow journalists ethics when making citizenship journalism via blogs, email lists, etc.?

According to WMSCI 2005 ***published acceptance policy***, the article was accepted for presentation as a ***non-reviewed*** one and because of the previous publications of its authors (the MIT's Ph.D. students). The reasons supporting this acceptance policy have been explained with details elsewhere (Callaos, 2014; pp. 7-10). These reasons are valid in some disciplines and not valid in other disciplines. There are reputable conferences with no peer-review at all. Examples can be found in the meetings of the American Mathematical Society: AMS, The Southeastern International Conference on Combinatorics, Graph Theory, and Computing, etc. (http://blog.computationalcomplexity.org/2007/11/unrefereed-does-not-equal-bogus.html). Another example is found in the prestigious, large, and very known INFORMS/IFORS conferences, of the Institute for Operations Research and the Management Sciences (INFORMS) and the International Federation of Operations Research Societies (IFORS), which we attended several times. They announce clearly and explicitly that "***Contributed abstracts are not reviewed and virtually all abstracts are accepted***."[17]

rs_submitted_to_WMSCI2005_%28Ed.%29_31-5-2014.pdf

[17] see for example http://meetings2.informs.org/sanfrancisco2014/abstract_contributed_i.html

Different disciplines have different conceptions regarding this issue. Then, ***what should a multidisciplinary conference do with this regard?*** Being WMSCI a multi-disciplinary conference we tried to apply a multi-modal acceptance policy in which the presentation of reviewed papers are combined the presentation of a small number of non-reviewed ones, but all those that would be published in the journal are or will be reviewed, some of them twice or three times.

ETHICAL ISSUES REGARDING WMSCI 2005 CASE

How many academics read this text above which was explicitly and clearly posted in WMSCI 2005 web site and respective call for papers? How many did so before rushing to judgment? Is it acceptable to judge a conference in a given discipline according the standards of other discipline? Is it ethical to smear a whole conference repeating half truths completely taken out of their context? Should this kind of academics provide education to our kids? What is the difference between this kinds of academics and the scientists who select what data from his/her observations to present and what not to present (or to hide) in order to confirm his/her hypothesis or pre-judgments? Should scientific ethics be followed just in the context of scientific activities while choosing not to follow it when judging activities of other academics? Isn't perplexing that reputable academics, with the very good intention of protecting Science from misbehavior, misbehave when judging other academic activities? Do these scholars have consciousness or awareness about the unethical behavior they are having while their intention is to do the right things of protecting Science from those who abuse it?

As we asked above, should scientists in a given discipline impose their disciplinary standards on academics from other disciplines? If the answer is yes, which discipline should impose its standards on other disciplines? Who are those who are going to make this kind of decisions? Should self-appointed gatekeepers of what they call "good science" impose their criteria by means of smearing who does not agree with them? Is that scientific? Is that ethical? ***Should intellectual intolerance be tolerated in the academic world? Shouldn't different academic perspectives be allowed and intellectually honest disagreement be allowed and even promoted and encouraged, especially in the universities and in research centers? Should the intellectual intolerance be considered as unethical behavior en Academia? Is it ethical not to, at least, try to stop or ameliorate any intellectual bullying in the academic world? How many academics are aware about the intellectual intolerance, bigotry, and bullying that is happening (according to an increasing number of academics) in the academic world?***

THE EVENT OF WMSCI 2005 AS A CASE STUDY

The above mentioned example was input to a "Case Study" that generated about 150 written and published pages. Thank to this case study a new Peer Reviewing Methodology emerged that took into account not just the ethical dimension but also the ***meta-ethical one***. *This case study was presented at a Workshop sponsored by the USA's National Science Foundation which included Faculty and Ph.D. Students in Business Administration of the University of South Florida.* A short article has been written regarding this case study; which we are including as an appendix of this article. It is a short article with pointers to larger articles with more details regarding the Action-Research project which supported (and still supports) the finding of potential solutions (or improvement of the implemented ones) for this ethical and meta-ethical problem.

It is important, for our purposes in this article, to note that computing writer Stan Kelly-Bootle[18] (2005) commented in *ACM Queue* that many sentences in the "Rooter" paper [accepted for

[18] STAN KELLY-BOOTLE "born in Liverpool, England, read pure mathematics at Cambridge in the 1950s before tackling the impurities of computer science on the pioneering EDSAC I. His many books include *The Devil's DP Dictionary* (McGraw- Hill, 1981) and *Understanding Unix* (Sybex, 1994). *Software Development Magazine* has named him as the first recipient of the new annual Stan Kelly-Bootle ElecTech Award for his "lifetime achievements in technology and letters." Neither Nobel nor Turing achieved such prized eponymous recognition. Under his nom de-folk, Stan Kelly, he has enjoyed a parallel career as a singer and songwriter." Copied from http://queue.acm.org/detail.cfm?id=1080884

presentation at WMSCI 2005, not necessarily for publication] were individually plausible. He thinks that this fact poses a problem for automated detection of this kind of articles and suggested that even human readers might be fooled by the effective use of jargon. He concluded as follows "I suppose the conclusion is that a reliable gibberish filter requires a careful holistic review by ***several peer domain experts***. Each word and each sentence may well prove individually impeccable, although nonsense ***in toto,*** *which* ***probably rules out for many years to come*** *a* computerized filter for both human and computer-generated hoaxes." This is an important conclusion for the purpose of this article, because it shows that ***peer reviewing methodologies should include a meta-ethical ingredient.*** Consequently, we thought that a combination of Action-Research, Action-Learning, and Action-Design would probably be an effective approach to incrementally design a peer-reviewing methodology that would include meta-ethical methods of procedures. As a result we think we designed a methodology which is more effective than the known ones. It is perplexing that with all previous failures in peer reviewing we found no explicit attempt in *designing, implementing, and testing* a more effective methodology. We did find many suggestions about how peer-reviewing might be improved. We actually included some of these suggestions in our methodological design, but we did not find any reference to the *implementation and testing* of a more effective peer reviewing methodology.

The events described above that happened after Stan Kelly-Bootle published the above mentioned article show clearly that he was right. Methodologies of quality assurance in Science proved not to be effective even in the approval process of doctorate dissertations. The Bogdanov Affair is an example regarding this issue. In Callaos (2011) we resumed this affair that included an incoherent Ph.D. dissertation as follow:

> "Five meaningless papers had been published by four leading journals in physics, and served as basis for the approval of the two Ph.D. Dissertations of the Bogdanov brothers. … John Baez, a physicist and quantum gravity theorist at the University of California at Riverside, moderated a physics discussion group entitled "Physics bitten by reverse Alan Sokal hoax" brought widespread attention to the Bogdanoff affair. Baez (2004) asserts that "Bogdanovs' theses are gibberish to me - even though I work on topological quantum field theory, and know the meaning of almost all the buzzwords they use. Their journal articles make the problem even clearer…some parts almost seem to make sense, but the more carefully I read them, the less sense they make... and eventually I either start laughing or get a headache… all they write about them is a mishmash of superficially plausible sentences containing the right buzzwords in approximately the right order. There is no logic or cohesion in what they write… Hermann Nicolai, editor of *Classical and Quantum Gravity*, told *Die Zeit* that if the Bogdanovs' paper had reached his desk, he would have immediately sent it back: 'The article is a potpourri of the buzzwords of modern physics that is completely incoherent'." (Baez, 2004). The editors of the journals where the articles were published reacted in different ways. "The editors of Classical and Quantum Gravity repudiated their publication of a Bogdanov paper, saying it 'does not meet the standards expected of articles in this journal'… Dr. Wilczek stressed that the publication of a paper by the Bogdanovs in Annals of Physics had occurred before his tenure and that he had been raising standards. Describing it as a deeply theoretical work, he said that while it was 'not a stellar addition to the physics literature,' it was not at first glance clearly nonsensical**.** 'It's a difficult subject,' he said. 'The paper has a lot of the right buzz words. Referees rely on the good will of the authors.' The paper is essentially impossible to read". (Overbye, 2002). Dean Butler wrote in *Nature* that **"the credibility of the peer-review system and journals in string theory and related areas is taking a battering."** George Johnson wrote an article about the Bogdanov affair in the *New York Times*, concluding that: "As the reverberations from the affair begin to die down, physicists seem to have accepted that the papers are probably just the result of fuzzy thinking, bad writing and **journal referees more comfortable with correcting typos than**

> **challenging thoughts**". In the same article Johnson added that "Dr. Sokal seemed almost disappointed." affirming that "If someone wanted to test a physics journal with an intentional hoax, I'd say, `more power to them'…What's sauce for the goose is sauce for the gander." (Johnson, 2002; emphasis added)."

Baez (2010) affirms that "Jackiw, a professor of physics at MIT, was one of two `rapporteurs' who approved Igor Bogdanoff's thesis. Overbye [2002] writes: Igor's thesis had many things Dr. Jackiw didn't understand, but he found it intriguing. "All these were ideas that could possibly make sense," he said. "It showed some originality and some familiarity with the jargon. That's all I ask."

Ignatios Antoniadis (of the École Polytechnique), who approved Grichka Bogdanov's thesis, reversed his review later. He told *Le Monde, "*I had given a favorable opinion for Grichka's defense, based on a rapid and indulgent reading of the thesis text. Alas, I was completely mistaken. The scientific language was just an appearance behind which hid incompetence and ignorance of even basic physics."[19] Other readers of the thesis claimed that they did not understand everything in it and they supposed that other readers do understand what they do not understand.

It is really perplexing that after the Bogdanov affair no one seemed to care about improving the quality assurance of Ph.D. dissertations and/or of peer reviewing in scientific journal, not even in Physics. Isn't that astonishingly perplexing? Why no one cared about taking the Bogdanov affair as a case study in order to improve the effectiveness of Ph.D. dissertations quality assurance and/or the effectiveness of Peer Reviewing? Is this kind of negligence ethical? Is it ethical just to denounce the Bogdanov Affair and announce the intention of making changes as to avoid similar situations? Is it ethical to just blame to the previous department chair and do nothing else regarding this kind of affair? We are not sure about the answers to these questions and this is why are making them? ***Our intention in making these questions is not a rhetorical one. This is why we think that each case like the examples shown above should be taken as a case study oriented to continuously improve the effectiveness of peer reviewing methodologies.***

SOME CONCLUSIONS

The following are among the conclusions we can make with regards to the content of this paper, which are also based on 1) the experience/knowledge we acquired through the Case Study of the WMSCI 2005 event, 2) the experience/knowledge we gathered through an incremental design and implementation of the peer reviewing methodology mentioned above, and 3) the information we gathered regarding similar events, e.g. the examples mentioned above.

1. One of the most important conclusions is that the most frequent source of the peer reviewing methodologies being used is for cases where scientific ***misconduct of authors coincide negligence or misconduct of reviewers*** of the respective article. Consequently, ***a peer reviewing methodology should have a meta-ethical ingredient*** related to both potential sources of misconduct: the authors and the respective reviewers. On the other side, academic departments and deanships as well as universities administrators and authorities should explicitly address the Academic Ethics and Meta-Ethics via caring and enforcing the expected ethical behavior in academic issues. It is our opinion that ethics enforcement should be less soft and more rigorous.

2. *Double-blind reviewing* facilitates and sometimes it might even catalyze the coincidence of author's misbehavior and reviewer's negligence or misbehavior. In double blind reviewing the authors names are not supposed to be published as related to the respective author. So, how would it be possible to include a meta-ethical ingredient with regards to reviewers' possible negligence or misbehavior in the context of this anonymity situation? This is why we added to the traditional double-blind reviewing a second reviewing tier with non-anonymous reviewers. In this sense, David Kaplan was our inspiration through his article "*how to Fix Peer Reviewing*" (Kaplan, 2005)

[19] Hervé Morin, 2002.

3. As we suggested above, we are convinced that the effectiveness of the Scientific Enterprise might be improved if grant Organizations and the academic promotional procedures relies less on structures based on the traditional peer reviewing methodologies.

4. If academic promotions are going to continue being based on journal publications and journal quality is going to be measured by its impact factor, the respective measure should not be limited to the relative quantity of citations of the respective journal. There are increasing efforts in addressing this issue.

5. Academic departments should make their own definitions of what is a peer and what peer reviewing methodologies will be acceptable for the discipline of the department.

6. Standards of some disciplines should not be imposed on other disciplines, because this might corrupt the nature of the discipline on which the other standards are being imposed.

7. More intellectual efforts should be done in creating awareness with regards to differentiating and not confusing the *ends* with the *means*, and not taking the means as ends in themselves; which certainly is ineffective with regards to the real ends and it might corrupt the nature of the means. Publication is a means, impact factors is a measure (among many other possible ones) of one of the properties of a mean; it is not and should not be an end in itself.

8. *There is an increasing necessity and urgency in addressing both the ethical and the meta-ethical dimensions of any research activities, not just as a moral issue but also as a* ***pragmatic*** *one.*

9. To use systemic (not necessarily systematic) peer reviewing methodologies which are adaptable (to different disciplines, for example) and might perfect themselves in the context of an evolutionary process based on an adequate ***integration of Action-Research, Action-Learning, and Action-Design***, in the context of a meta-methodological incremental planning and evolutionary methodological re-design and meta-design.

10. This conclusion is based on our interpretation (or informed opinion, or judgment) regarding some ways which were taken by some academics (and graduate students) to deal with the problems that emerged from academics who misbehaved, or from the intrinsic failures and weaknesses of the traditional peer revising methodology which mostly is being used. In our opinion more attention should be paid to Intellectual Intolerance and to the increasing academic cyber-bullying and cyber-inquisition being practiced by some academic vigilantes who are self-nominated prosecutors, juries, and judges on the name of what they consider "Good Science". Some of these people are well intentioned scholars but they are not aware that they are forming part of lynching mobs and that they are being mislead by people with vested interests or promoting autocratic (and consequently anti-academic) Intellectual Inquisitors. We understand that this is the result of speech freedom and academic autonomy. We also understand that tenured professors should be able to speak their mind; which is very important in honest scientific disagreement and academic freedom. But, is it right to use this freedom to smear prestigious organization like IEEE, ACM, ASME, SIAM, Springer Verlag, etc.?[20] Is this ethical? What academic criteria are being followed when smearing all conferences of these organizations that have been providing adequate support for academic and professional activities for so long time? Should the deficiencies of peer reviewing be used to smear and defame so many academic and professional organizations? Is that ethical? For how long we should have an intentional blindness not identifying the inherent of peer reviewing and continue blaming its failures on the organization using them? Isn't an ethical obligation to identify the right problem and to try to fix it? We are not talking here just about anonymous bloggers, but also about academics and librarians that have earned the respect of some of their colleagues. Did these scholars and librarians thought about the harm they are doing to the same scientific processes and academic activities they are supposed to be protecting, with very good intentions in some of them. Did

[20] See for example http://fakeconferences.blogspot.com/. 20,100 results are showed when entering "IEEE bogus conference" in Google. 5,890 results when entering "ieee fake conference".

they think about the ethical issues of their behaving? Are they unintentionally misbehaving? Did they think about the new kind of inquisition in which they are being acting, simultaneously, as prosecutors, judges, juries, and executioners by means of web pages that they create, in which they lump together many organizations and refer to them as predators? In the hypothetical case that all what they are listing are predatory journals or organizations[21], aren't they meta-predators, masked with vigilantes of scientific and academic activities? Are they solving the real problem? Are they contributing to the solution of the right problem? Can we blame journals editors and conference organizers for the misbehavior of reviewers and/or authors? Can we blame them for the constant failures of the traditional peer reviewing methodology? Can we blame the driver for consequences of an accident because he/she was required to drive a malfunctioning car? Who is to blame? The driver? The car manufacturer? The boss who required the driver to drive this car? What would be the ethical and practical answer? Is an ostrich strategy an ethical and practical one? Should we address the real problem which is a very complex one instead of doing simple tasks that, far from solving the problem, might create more problems and potentially hurt innocent people by smearing their character, integrity, and honesty? Is this ethical? Is this fair? Is this practical? Is this congruent with the main purpose of Academy which is to always seek the truth?

[21] See for example at **http://scholarlyoa.com/publishers** a list of what have been named as "Potential, possible, or probable predatory scholarly open-access publishers." This list is being taken into account in processes of academics and librarians promotions. We are not sure if some of listed publishers were contacted before or after listing them. But, we are certain that some editors of journals and organizations included in this list were not asked about their peer reviewing processes. Wikipedia consensually and collectively identified ten criteria to identify predatory publishers are in complete disagreement with Beall's list criteria. Which one should be used? Some of the publishers listed in Beall's list are 100% not "predatory publishers" because none of these criteria apply to them. Is it not an ethical obligation to identify a consensually and collectively standardized set of criteria before listing publishers as predators? Is it academically acceptable to take the criteria dictated by one or a group of persons as the *de facto* standard for the identification of predatory publishers? Is it academically ethical not to seek the truth and to impose the criteria of one or few persons on the labeling of journals as predators? Is it adequate to use this kind of individual lists in decisions oriented to academic promotions? Furthermore, the criteria followed to define this list automatically exclude any academic innovation and/or entrepreneurship. We were informed about the good intention of the librarian who produced this list, and we do not have any doubt about it. But, is this really the way to deal with unethical behavior of some publishers? Is it ethical to smear so many journals and organizations just because they do not follow the criteria of a well intentioned librarian? How many academics were hurt in their careers just because they published in some journal listed in the list? Should departments' chairs and deans use this list in their decisions regarding the promotion of academics? Is that fair? Is that ethical? These are not rhetorical questions, but questions that have been made with the purpose to trigger reflections on this kind of issues.

REFERENCES

Alvesson, M. and Sköldberg, K., 2001, 2009, *Reflexive Methodology: New Vistas for Qualitative Reseach*, London: Sage Publications

Anderson, M. S., Martinson, B. C., and De Vries, R., 2007, "Normative dissonance in science: results from a national survey of u.s. *Scientists," JERHRE* 2, 3–14. doi: 10.1525/jer.2007.2.4.3. Referenced in Brembs, et al. 2013.

Baez, J., 2004, The Bogdanoff Affair. Retrieved March 7th, 2007, and on and on September 7, 2014 from http://math.ucr.edu/home/baez/bogdanov.html.

Brembs, B., Button, K., and Munafò, M., 2013, "Deep impact: unintended consequences of journal rank," *Frontier in Human Neuroscience*, 23 June 2013, doi: 10.3389/fnhum.2013.00291; at http://journal.frontiersin.org/Journal/10.3389/fnhum.2013.00291/full

Callaos, N., 1995, *Metodología Sistémica de Sistemas*, (*Systemic Systems Methodology*) Caracas: Universidad Simón Bolivar; 685 pages.

Callaos, N. 2005, *Meaning of "Peer Review,"* informally (with no previous peer review) published at

https://www.academia.edu/4437203/Meaning_of_Peer_Review

Callaos, N, 2006, *JSCI Editorial Peer Reviewing Methodology*, at http://www.iiisci.org/Journal/SCI/Methodology.pdf

Callaos, N., 2011, *Peer Reviewing: Weaknesses and Proposed Solutions* at https://www.academia.edu/4437207/Peer_Reviewing_Weaknesses_and_Proposed_Solutions

Callaos, N., 2014, *With Regards to the Bogus Papers Submitted to WMSCI 2005, at* http://iiis.org/contents/With_Regards_to_the_bogus_papers_submitted_to_WMSCI2005_%28Ed.%29_31-5-2014.pdf

Callaos, N. and Callaos, B., 2014, *Toward a Systemic Notion of Methodology: Practical Consequences and Pragmatic Importance of Including a Trivium and the Respective Ethos, Pathos, and Logos www.iiis.org/Nagib-Callaos/Toward-a-Systemic-Notion-of-Methodology*

Campbell, H., 2014, "The Corruption of Peer Review Is Harming Scientific Credibility," *Wall Street Journal*, July 13, 2014, http://online.wsj.com/articles/hank-campbell-the-corruption-of-peer-review-is-harming-scientific-credibility-1405290747.

Corneliussen, S. T., 2014, *Wall Street Journal* op-ed: "Corruption of peer review is harming scientific credibility," Physics Today, 2014, at http://scitation.aip.org/content/aip/magazine/physicstoday/news/10.1063/PT.5.8057

Chubin and Hackett, 1990, *Peerless Science, Peer Review and U.S. Science Policy;* New York, State University of New York Press

DuBois, J. M. Anderson, E. E. and Chibnall, J., 2013, "Assessing the Need for a Research Ethics Remediation Program," *Clinical and Translational Science,* Jun 2013; 6(3): 209–213. Also at http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3683893/

Etherington, K, 2004, Becoming a reflexive researcher: Using Ourselves in Research, London: Jessica Kingsley Publishers.

Gilbert, N., 2009, "Editor will quit over hoax paper: Computer-generated manuscript accepted for publication in open-access journal," *Nature*, 15 June 2009, doi:10.1038/news.2009.571; at http://www.nature.com/news/2009/090615/full/news.2009.571.html

Gross, A. G., 1996, *The Rhetoric of Science*, Cambridge, Massachusetts: Harvard University Press

Gross, A. G., 2006, *Starring the Text: The Place of Rhetoric in Science Studies*, Carbondale: Sothern Illinois University Press.

Hyland, K. 2008, "Persuasion, interaction and the construction of Knowledge: Representing self and others in research writing, *International Journal of English Studies*," Vol. 8, #2, pp. 1-23

Johnson, G, 2002, In theory, it's true (or not?). *The New York Times*, November 17.

Kaplan, D., 2005, How to Fix Peer Review, *The Scientist*, Vol. 19, Issue 1, p. 10, Jun. 6.

Kelly-Bootle, S. 2005, "Call That Gibberish," *ACM Queue*, Vol. 3 No. 6 – July/August 2005; retrieved on August 4, 2014 at: http://queue.acm.org/detail.cfm?id=1080884

Lawrence, P. A., 2008, "Lost in publication: how measurement harms science," *Ethics in Science and Environmental Politics*, Vol. 8: 9–11, 2008, doi: 10.3354/esep00079, Printed June, 2008, Published online January 31, 2008

Morin, H., 2002, *La réputation scientifique contestée des frères Bogdanov*,, Le Monde, accessed on September 8th, 2014 at http://www-cosmosaf.iap.fr/Le%20Monde_fr%20%20La%20r%C3%A9putation%20scientifique%20contest%C3%A9e%20des%20fr%C3%A8res.htm

Overby, D., 2002, Are they a) Geniuses or b) Jokers? *The New York Times*, November, 9, 2002.

Physics Today, *Peer-review fraud cited in retraction of 60 academic papers*, July 11, 2014 at http://scitation.aip.org/content/aip/magazine/physicstoday/news/news-picks/peer-review-fraud-cited-in-retraction-of-60-academic-papers-a-news-pick-post

Schön, D. 1983, *The Reflective Practitioner: How Professionals Think in Action*, USA: Basic Books. Inc.

Simon, H. W. (Ed.), 1990, The Rhetorical Turn: Invention and Persuasion in the Conduct of Inquiry; University Of Chicago Press

Swaine, J., 2014, "Academic journal retracts articles over 'peer review ring' with bogus scholars," The Guardian, at http://www.theguardian.com/media/2014/jul/10/academic-journal-retracts-articles-peer-review-ring

Van Noorden, R., 2011, "The Trouble with Retractions: A surge in withdrawn papers is highlighting weaknesses in the system for handling them," Nature 478, 26-28 (2011) Published online 5 October 2011, doi:10.1038/478026a; also at http://www.nature.com/news/2011/111005/full/478026a.html

Van Noorden, R., 2014, "Publishers withdraw more than 120 gibberish papers", *Nature*, doi:10.1038/nature.2014.14763. Also at http://www.nature.com/news/publishers-withdraw-more-than-120-gibberish-papers-1.14763

Zimmer, C., 2012, "A Sharp Rise in Retractions Prompts Calls for Reform," *The New Work Time*, April 16, also at http://www.nytimes.com/2012/04/17/science/rise-in-scientific-journal-retractions-prompts-calls-for-reform.html?_r=1&src=dayp

APPENDIX

Improving Peer-Reviewing: A Case Study Triggered by the Acceptance of a Bogus Paper

Nagib CALLAOS

International Institute of Informatics and Systemics (IIIS, www.iiis.org)

Presented at the ***Workshop on "Using the Case Method for Instruction"***
Funded by The National Science Foundation

Held in College of Business of the *University of South Florida*, Tampa, Florida, USA,
Participants: Faculty and doctoral students interested in using the case method, developing discussion and research cases, and employing classroom and distance technologies.

Organized and facilitated by Professor T. Gordon Gill, *University of South Florida*, USA

PURPOSE

The objectives of this very short paper is 1) to briefly describe the sequence of the search/research activities that were triggered by the acceptance of a fake paper submitted to WMSCI 2005 and 2) to present the different reports that were generated by means of a) literature search regarding this kind of problem, b) the published potential solutions, and c) the implemented solution, which was identified by a methodological research fundamentally based on *action-research*, *action-design*, and *action learning*. At least 3000 hours (of senior academics, conference organizers, and journal editors) have been invested in this case study.

In this short paper, we will make a very short description with links to other detailed and larger papers which are being generated as a consequence of this case study and the tentative solutions that has been implemented, which in turn might provide input for more case studies regarding this important issue of improving peer reviewing processes.

MAIN EVENTS

The respective main events and search/research activities have been, up to the present, the following:

1. Randomly generated papers were submitted to WMSCI 2005. Some of them were identified as such by their respective reviewers and were rejected. No reviews were received for one of them and then according to the published policy of the Organizing Committee, the paper was accepted as a ***non-reviewed*** one, because of the **CVs** of its respective authors (three MIT's PhD students). They were told that the paper will be included in the proceedings (with an explicit note) as a *non-reviewed paper*, but if the Organizing Committee received reviews recommending the acceptance of the paper then its status would change to a peer-reviewed one. A more detailed description, where facts were separated from reasoned opinions and judgments, can be found at www.iiis.org/wmsci2005-facts-and-reasoned-judgements (15 pages)

2. All hell broke loose after the email acceptance was sent. Reuter distributed the news as "a computer generated paper was accepted for presentation at a computer science conference." BBC, CNN, Boston Globe, etc. published the news. Half truths and blatant smearing and lies, as well as personal attacks invaded the blogosphere related to Computer Science.

3. Our huge surprise was that, even after the above mentioned events, we received reviews recommending the acceptance of the gibberish paper. This event couldn't be more astonishing and disconcerting to us. ***Was something wrong (unethical) with some of our reviewers? Was something wrong with our reviewing methodology? How could we have a more effective reviewing methodology?***

4. Point 3 triggered a search process for more information and the more information we gathered the more certain we were that we needed a reviewing methodology different to the traditional and most used one. Parallel to the literature search (not research), we organized conversational sessions and focus groups in the context of the 2006, 2007, and 2008 conferences. Interested attendees of these events were asked the questions that our search was producing. Results of these conversational sessions were included as appendixes of the document posted at http://www.iiis.org/nagib-callaos/peer-review/ (pages 76-107).

5. Results of the processes described in point 4 triggered action-research processes which produced action-design and action-learning processes, in the context of an incrementally-evolutionary methodology to identify the ways of improving traditional double-blind peer reviewing methods.

CONCLUSIONS OF THE SEARCH/RESEARCH

1. The most essential conclusions were as follows

    a. A *high level of agreement among reputable journals' editors* regarding the low effectiveness, weaknesses, and high frequency of failure in peer-review methods. Combining these opinions, perceptions, and facts with the huge amount of time spent (invested?) in peer reviewing, it is easy to conclude that we are facing an important problem that require some solutions. It is estimated that 15.000.000 of yearly hours of work are used in peer reviewing processes (more than what the USA invested in the whole Genome Project); about one billion dollars each year while (according to a survey of members of the Scientific Research Society) "only 8% agreed that 'peer review work well as it is'." So, is peer-reviewing cost-effective? Details regarding the high level of agreement regarding the low level of effectiveness of peer review can be found in pages 1-20 of the report posted at http://www.iiis.org/nagib-callaos/peer-review/

    b. No agreement regarding a standard peer-reviewing methodology.

    c. Lack of agreement regarding the meaning of "Peer" and "Peer-Review." More details at http://www.iiis.org/nagib-callaos/meaning-of-peer-review and at http://peerreviewing.wordpress.com/2012/05/19/meanings-of-peer-and-peer-review/

    d. Lack of agreement about what a conference is and what are, or should be, conferences' objectives. In one extreme, some conferences have peer reviewing standards similar to journals in the respective discipline. In the other extreme, there are reputable conferences with no peer-review at all. Examples are the meetings of the American Mathematical Society: AMS, The Southeastern International Conference on Combinatorics, Graph Theory, and Computing, etc. (http://blog.computationalcomplexity.org/2007/11/unrefereed-does-not-equal-bogus.html). Different disciplines have different conceptions regarding this issue. Then, ***what should a multidisciplinary conference do with this regard?***

    e. Lack of explicitly written information regarding what a conference's proceedings is and what it should contain.

    f. Disagreement among different disciplines with regards to their conceptions of what "conferences" are for and what is, or should be, the functions of their respective proceedings. Consequently, ***what should a multidisciplinary conference do regarding this issue?***

    g. A more adequate reviewing methodology was needed, especially for multi-disciplinary conferences organized for inter-disciplinary communication.

POTENTIAL SOLUTIONS

With the above mentioned results of our search, we tried to design and implement a *Reviewing Methodology for a multi-disciplinary conference* and to explicitly publish what we understand by each of the concepts, objectives, functions, and notions where no explicit standards or implicit agreement exist. The meta-methodological process we have been (and we are still following) following is based on a combination of *action-research, action-design, and action-learning in the context of an evolutionary, incremental, and cybernetic process.*

Up to the present we obtained the following results:

1. We identified the objectives of peer-reviewing: pages 20-35 of the report posted at http://www.iiis.org/nagib-callaos/peer-review/

2. We identified the meaning of Peer-Review, or what we understand by it, and published in the IIIS's conferences web sites and at www.academia.edu/4437203/Meaning_of_Peer_Review

3. We proposed possible solution in pages 35-39 of the document mentioned in point 1. This solution has already been implemented with a reasonable level of effectiveness and success.

4. We proposed A Systemic Model of Scholarly and Professional Publishing and the architecture of its respective supporting information system in pages 39-61 of the document mentioned in point 1. (also at https://www.academia.edu/4437267/Systemic-Cybernetic_model_for_reviewing_and_publishing). We implemented about the 80% of what has been proposed but because of financial lack of support the proposed system has not yet been completely developed.

5. We proposed and we are working with a three-tier reviewing methodology:

    a. Traditional double-blind with a minimum of 3 reviewers and with an average of about 4 actual reviews as reported in the forewords of the respective proceedings.
    b. Non-anonymous, non-blind with a maximum of three reviewers.

c. Peer-to-peer reviewing (the reasoning supporting this kind of review is presented in pages 61-67 of the above mentioned document.

More details regarding this methodology can be found in "A Multi-Methodological Reviewing Process for Multi-Disciplinary Conferences" that is being posted at all conferences sites, e.g. http://www.iiis2014.org/wmsci/Website/MMRPfMDC.asp?vc=1 A short description of a basic two-tier methodology has been posted at http://iiis.org/peer-reviewing.asp

6. We posted in all conferences sites what are, for us, the objectives of conferences and the functions of the respective proceedings. What we posted was the results of many conversational sessions and focus groups with attendees of our conferences. http://www.iiis2014.org/wmsci/Website/FunctionsofConferencesProceedings.asp?vc=1

7. We have been successfully using a newly designed two-tier methodology for Peer Reviewing in which we combine *traditional double-blind* peer reviewing as a ***necessary*** condition, but not as a ***sufficient*** one. A *non-blind* peer reviewing is also required in the methodology we are using since 2006. A short description of this methodology can be found at page http://www.iiisci.org/Journal/SCI/Methodology.pdf

We posted in the web as many documents as we could in order to continue with the collective efforts of the IIIS's members and its conferences' attendees in contributing for a continuing improvement of the effectiveness in peer reviewing and in adapting the objectives of the conferences and the functions of its respective proceedings to the users of our conferences, who are their actual attendees. Continuing with this process is the essence of the meta-methodological process we are following which combines action-research, action-design, and action-learning in the context of an evolutionary, incremental, and cybernetic process, by means of collective contributions to this process.

A Significantly Indicative Event Happened After the Presentation Was Made at the Workshop (which was resumed above)

The peer-reviewing methodology, briefly described above and in the linked references seems, to have been quite ***effective*** especially if we take into account that "The publishers Springer and IEEE are removing more than 120 papers from their subscription services after a French researcher discovered that the works were computer-generated nonsense." (http://www.nature.com/news/publishers-withdraw-more-than-120-gibberish-papers-1.14763?WT.mc_id=TWT_NatureNews). Since 2006, all fake papers we received were identified by our two-tier methodology which is described with more details at http://www.iiisci.org/journal/sci/Methodology.pdf and http://www.iiis.org/acceptance-policy.asp. Even we cannot prove that our methodology is more effective (but less efficient because it requires more persons-hours in peer reviewing and acceptance processes), we have several reasons and indicators to believe that it is definitely more effective. One of this indicators is the recent news regarding prestigious publishers trying to remove about 120 fake papers from their publications, while no case has been presented up to the present with our two-tier methodology.

REALIZING A DISCIPLINARIAN STATE OF BEING FROM AN INTERDISCIPLINARY APPROACH OR AN INTERDISCIPLINARIAN STATE OF BEING FROM DISCIPLINES

Matthew E. Edwards
Department of Physics, Chemistry & Mathematics, Alabama A&M University
Normal, AL 35762, USA

ABSTRACT

An interdisciplinarian is a focusedly learned individual who has had both additional expert tutelage and "synergetic knowledge connections," resulting in the latter from convolvement learning of comparative and contrasting information and methods. Secondly, to be a multidisciplinarian is to be knowledgeable in two or more disciplines without having had the benefits of expert tutelage or "synergetic knowledge connections." Thirdly, a disciplinarian is a focusedly learned individual possessing vast amounts of related information and understanding in a single field of study, resulting from additional expert tutelage, thus allowing the individual to be able to investigate new concepts, serve an organization, solve new problems, or make new products. This same ability to investigate new concepts, serve an organization, solve new problems, and make new products exists for the interdisciplinarian as well, but far less so if at all for the multidisciplinarian individual.

These three vastly different states of being are what we call in this research Career-path Alliances. Each Career-path alliance can manifest through opportunities where an individual can persist by doing scholarly activities on one hand, or serving organizations, practicing professional activities, or entering early career choice positioning on the other. How to achieve a Career-path alliance and sustain the same is an interesting contemplation. To that extent, we have reviewed the Career-path alliances and illustrated here seven structures that illumine timelines to achieve such states of being. Also, along with providing critical information on issues pertaining to achieving each Career-path alliance, particularly regarding socioeconomics of different groups of individuals, we denote how to maintain or persist in each alliance once achieved, and how to transition from one alliance to another, while still maintaining a scholarly demeanor, a servicing posture, a professional practicing behavior, or an early career choice participation stance after either the interdisciplinarian or disciplinarian alliance has been achieved.

1. INTRODUCTION

Originating from since the early days of formalized degree-granting universities, the notion of learning sufficiently to be a disciplinarian with a specific degree has been the desired as well as the only end-result state of being available to aspiring graduates [1]-[4]. And as such, this initial state of being, this Career-path alliance, as we refer to it, has become the standard and has persisted continuously as such, as the accepted norm. But of late, beginning in the early-middle part of the 20th century and continuing to this point, the notion of becoming an interdisciplinarian has gained considerable attention, which offers an interesting alternative to being a disciplinarian [1], [5]-[12]. Through its style of expression, with a growing group of advocates and stakeholders, the interdisciplinarian state of being is considered by some to be just as viable if not more so than that of being a disciplinarian. Moreover, with these two indicated alliances, one could be inclined to think that the co-existence of both disciplines and interdisciplines is without complication or complexity, and that each is accepting of the other, respectively, by its advocates and stakeholders. Yet, such thinking is simply not true as rivalries and mistrust abound between the two opposing factions.

In addition, another component to this mix is what of being a multidisciplinarian, the individual who by definition is familiar with several disciplines. Our research and that of others have shown that the multidisciplinarian state of being [1, 13] is the least viable one for competency when compared to the disciplinarian or interdisciplinarian state, and as such, an individual should persist only briefly as a multidisciplinarian and strive mightily to transition to either a disciplinary or interdisciplinary state of being

at the first opportunity. Otherwise, such a person remains effectively trapped in what could be a minimally productive, lesser rewarding, and essentially a stymied participatory state of being.

Additionally, in this research, each of the three end-products or state of being—interdisciplinarian, disciplinarian, and multidisciplinarian—is discussed independently as separate Career-path alliances; and, although extensive literature presently exists on each individual Career-path alliance [14]-[16], not so much exist on transitional pathways between the alliances. Thus, how does one transition from one state of being to another is a desired outcome, and we present below in section 2 methods of such transitions. In addition, while understanding relevant patterns of early career choice positioning, professional practices, servicing routines, or scholarly endeavors is as important now in this the 21st century, if not more so than ever it was at any point in the past, acquiring an understanding of either pattern is obscured thus requiring greater effort to unfurl its intricate details, and pursuing the task of achieving one pattern in a specific Career-path alliance demands constant attention and focused effort. In this regard, we show in section 2 below the steps or components of achieving each Career-path alliance as well as, how to transition from one to another. Also, regarding the disciplinarian and interdisciplinarian alliances, we present well established documented disciplines and interdisciplines that will significantly impact our lives in this the 21st century and beyond.

2. METHODS: CAREER-PATH ALLIANCES (STATES OF BEING) AND TRANSITIONS

2.1. The Disciplinarian

In Figure (2a), the leftmost box shows the typical and expected training required for embarking onto a successful career opportunity as a disciplinarian. The disciplinarian's training before college consists of any and all parts of formal studies: pre-K, kindergarten, primary, elementary, junior high school, and high school. Next, this box depicts college/university training resulting in the B.A./B.S. degree followed by the M.A./M.S., Ph.D., or equivalent degrees, and finally a Post-doc experience. Lastly, the box shows expert tutelage as the first part of directed learning. Any or all of these training activities are desired or needed to achieve various states of being.

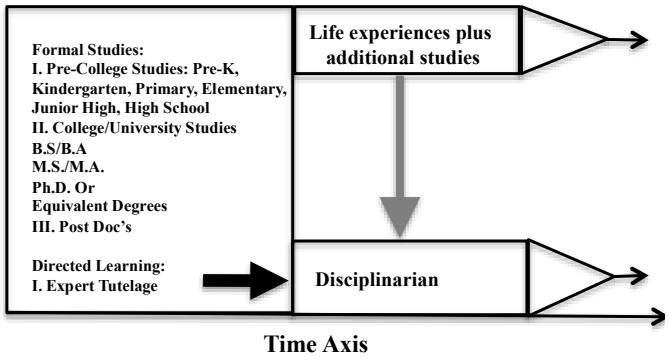


Figure (2a) Direct Disciplinarian diagram

Moreover, with these levels of training, the Figure shows that the individual is equipped to enter the realms of being a disciplinarian, with its rightmost top box expressing life experiences plus additional studies that serve to provide enhancement and sustaining "fodder" or "knowledge nutrients" to this individual who functions as a disciplinarian. Note that this structure remains applicable to all individuals who enter the workforce either as an early career choice position, a service providing position, a professional practicing position, or a scholarly endeavor activity. The horizontal axis indicates the time and as such represents an unspecified time for achieving and then sustaining the desired Career-path alliance, which in this case is that of the disciplinarian. An individual can persist in this alliance through his/her career lifetime if that is their desire. The rightmost two boxes stacked vertically with an intervening directional arrow depict a continuum and an indefinite pursuit with time being shown on the horizontal axis. As stated earlier, this disciplinarian structure is the standard or norm; it is the one that is expected and what is typically embraced as the ideal structure to obtain for either the career choice position, the service providing position, the professional practice position, or the scholarly endeavor activities. In this regard, impactful disciplines in the 21st century and closely related fields to our interests are: Physics [17,18], with two related papers, Chemistry, Mathematics, Biology, Electrical Engineering, and Mechanical Engineering.

2.2.The Interdisciplinarian

Figure (2b) illustrates the direct pathway of becoming an interdisciplinarian. As was the case in Figure (2a), the essential, formal studies are obtained plus the additional requisite activities of directed learning, consisting now of both expert tutelage and convolvement learning. This figure indicates the process of emerging interdisciplinarity early career choices, servicing routines, professional practices or scholar endeavors. In addition, the life experiences plus additional studies continue to enhance the direct interdisciplinarian with no regard to termination. No doubtedly many existing interdisciplinarians have followed this pathway to their present positions; moreover, many active interdisciplinarians exist or engage as interdisciplinarian by first formally securing career stability or job security as disciplinarians, and then actively operating as an interdisciplinarian.

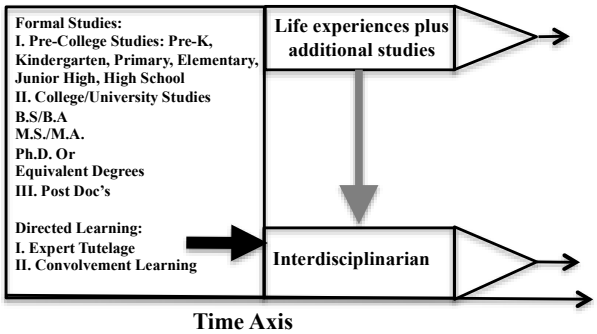


Figure (2b) Direct Interdisciplinarian diagram

In this regard, several important interdisciplinary areas or fields that are of interest to us, while not being exhausted, are: Materials Science [19, 20], with two related papers, Biomedical Engineering, Biochemistry, Biophysics, and Information Technology.

2.3. The Multidisciplinarian

What are the issues and particulars to being a multidisciplinarian? First and foremost, being a multidisciplinarian should not be thought of as an end Career-path alliance within itself, although it often occupies a large part of some individuals' existence. In this regard, some individuals find themselves persisting in what might be called a knowledge wasteland, manifesting as being a lower form of the "Jack of all trades, master of none" syndrome. Yet, being a multidisciplinarian, as will be shown later, is an integral part of Career-path alliances to becoming a bona fide interdisciplinarian or a disciplinarian, as well, through the transition pathways. Thus, in Figure (2c), components for being a multidisciplinarian are given primarily as a passing through activity rather than as components of a position to achieve as the culmination at the end of a Career-path alliance. Once again, as Figure (2c) shows all the initial formal studies occur, as for the case of the above disciplinarian or interdisciplinarian, with the addition of life experiences plus additional studies. Yet, for whatever reason and the causes are many and varied, either the expert tutelage, which is now missing in the leftmost box did not occur for this individual to emerge as a bona fide expert in his/her chosen area of interest or it has not been obtained from the topmost box denoting the continuum of life experiences and additional studies. In addition, as for as being an interdisciplinarian, no synergetic convolution has occurred either, which existed as a prerequisite in Figure (2b). Although the multidisciplinarian is often learned with vast knowledge in some cases, ultimately the individual's training has not led to having convolved synergetically between components of his/her knowledge. Thus, this individual remains unfocused and rather incompetent in today's workforce; he/she is ill-equipped to function in an early career-choice position, a service providing position, a practicing professional position, or in a scholarly endeavor.

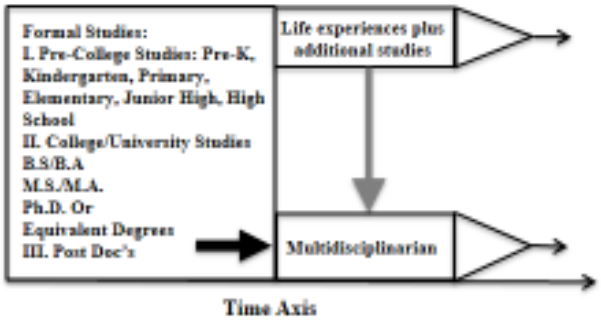


Figure (2c) Direct Multidisciplinarian diagram

2.4. The Interdisciplinarian From a Multidisciplinarian

In above section 2.2, Figure (2b) illustrates the Career-path alliance of becoming an interdisciplinarian directly from formal studies and directed learning, occurring as the leftmost box

indicates; however, Figure (2d), below, which is an extension of Figure (2c), depicts the method of becoming an interdisciplinarian from first being a multidisciplinarian. Here, Figure (2d) indicates the process of extending a multidisciplinarian's development and understanding with expert tutelage and synergetic convolvement, resulting in the emergence of an interdisciplinarian in any of the four stages, as a career choice position individual, a service providing position, a professional practicing position or scholarly endeavors. Now, the inclusion of expert tutelage plus convolvement learning in Figure (2d) allows an individual to emerge as an interdisciplinarian. Undoubtedly many existing interdisciplinarians have followed this pathway to their present positions; however, many active interdisciplinarians exist, as such, by formally securing career stability or job security as disciplinarians but functions as an interdisciplinarian.

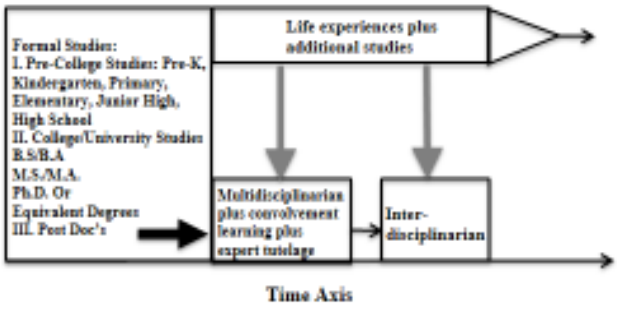


Figure (2d) Direct Transition to Interdisciplinarian

2.5. The Disciplinarian From a Multidisciplinarian

Here, the corresponding question is often asked of how to become a disciplinarian from the position of first being a multidisciplinarian. As in the case for emerging as an interdisciplinarian, Figure (2e) shows that the individual must receive the additional expert tutelage while being a multidisciplinarian, thus ending the multidisciplinarian state of being and concomitantly transitioning into a single, cohesive disciplinarian, as now this functioning individual would be.

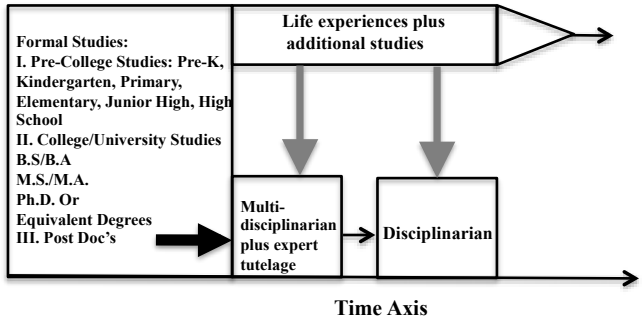


Figure (2e) Direct Transition to Disciplinarian

2.6. The Disciplinarian From an Interdisciplinarian

Figure (2f) shows the indirect transition to being an interdisciplinarian from the previous states of being a multidisciplinarian to a disciplinarian as the final state of being. The middle bottommost box indicates the stage of deconvolving from being an interdisciplinarian. Thus, this indirect transition is one of the most likely Career-path alliances to becoming a disciplinarian through the Interdisciplinary pathway.

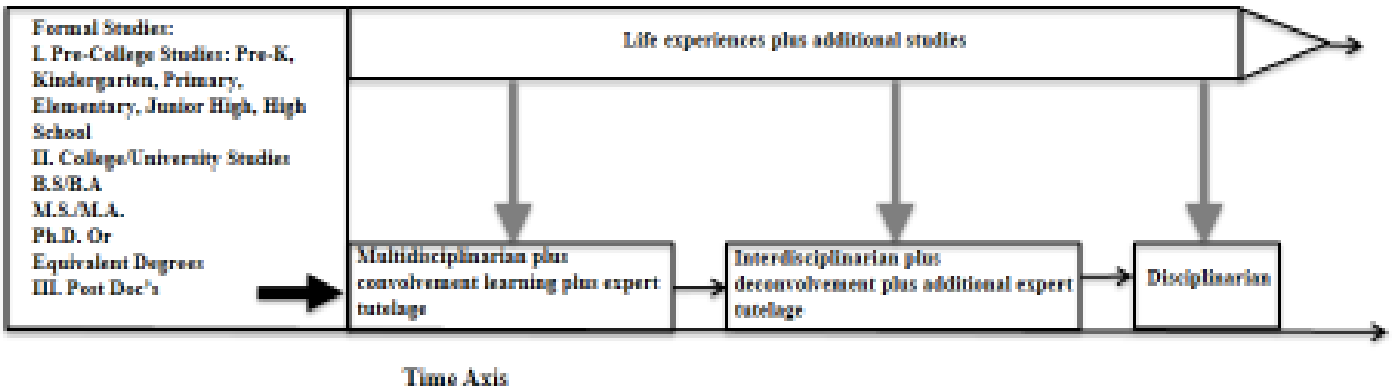


Figure (2f) Indirect Transition to Disciplinarian Through Interdisciplinarian State

2.7. The Interdisciplinarian From a Disciplinarian

Figure (2g) ends in the establishment of an interdisciplinarian from a disciplinarian. This second indirect transition ensues as the other one does, beginning with formal studies and progressing onto becoming a multidisciplinarian. Then, the multidisciplinarian combines the experiences and activities of expert tutelage resulting in a disciplinarian state of being. Lastly, the individual combines convolvement learning, which yields the indirect transition to the interdisciplinarian state of being.

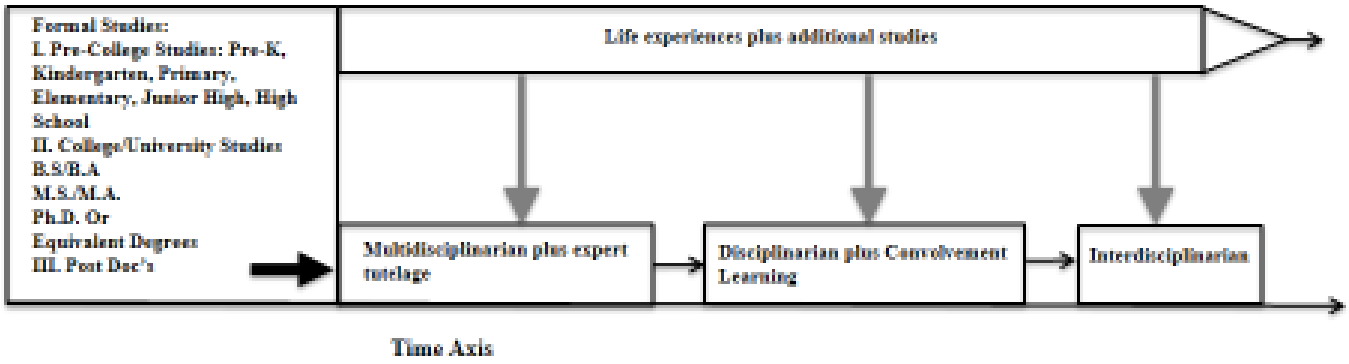


Figure (2g) Indirect Transition to Interdisciplinarian Through Disciplinarian States

3. DISCUSSIONS AND CONCLUSION

Often individuals having strong parenting and socio-economic advantages can ideally emerge through the direct Career-path alliances as a disciplinarian or interdisciplinarian; however, lifetime experiences show that often other individuals with less strong parenting support and socio-economic disadvantages can achieve the same outcomes, either disciplinary or interdisciplinary, from first quiescing temporarily in some cases or from persisting sometimes longer as a multi-disciplinarian. Then after sometime, the individual accrues the expert tutelage for being a disciplinarian, and becomes such, having now what might be called a controlled straight line trajectory state of being, having deconvolved and slough off useless activities or on the other hand acquires the additional, prerequisite convolvement learning resulting in the transition to an interdisciplinarian, with now a "controlled spiraling circulatory" state of being instead of being uncontrolled. For such an individual, with less than ideal parenting and socioeconomic disadvantages 'the village" or effective, global communal support [21-22] is often what is needed to fill critical voids.

Since the multidisciplinarian Career-path alliance is the state of being of an underdeveloped, non-focused individual, one should persist, as such, in this state of being just long enough to transition to either the disciplinarian or the interdisciplinarian state. Otherwise, the individual remains trapped in less than a viable or productive state of being, often with an incoherent, uncontrolled spiraling state of being.

While being a disciplinarian is still the ideal alliance, particularly pertaining to achieving tenure and other job security, at the modern workplace, the interdisciplinarian has gained in credibility to the extent of being viable and competitive to the disciplinarian alliance, thus offering an interesting alternative.

Finally, our research when depicted in Figures (2a) - (2g), the outcome show that states of being (Career-path alliances) structures can be generated, depicting direct occurrences in three cases and transitional state of being in four others, and the achievement of each Career-path alliance rests on the motivation, the internal drive, and the aspirations of the pursuer.

4. ACKNOWLEDGEMENT

Thank goes to Dr. Afef Janen, research associate, for invaluable content discussions and assistance with graphics and formatting, Ms. Dianne Kirnes for editorial assistance, and Mrs. Glenda R. Edwards, for assistance with life experiences discussions.

5. REFERENCES

[1] Augsburg, Tanya, (2006). "Becoming Interdisciplinary: An Introduction To Interdisciplinary Studies," 2nd, edition, Kendall/Hunt Publishing Co.

[2] Lindholm-Romantschuk, Y. (1998). Scholarly book reviewing in the social sciences and humanities. The flow of ideas within and among disciplines. Westport, Connecticut: Greenwood Press.

[3] Gibbons, Michael; Camille Limoges, Helga Nowotny, Simon Schwartzman, Peter Scott, & Martin Trow (1994). *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*. London: Sage.

[4] Dogan, Mattei & Pahre, R. (1990). "The fate of formal disciplines: from coherence to dispersion." In *Creative Marginality: Innovation at the Intersections of Social Sciences*. Boulder, CO: Westview. pp. 85–113.

[5] Baldick, C. (1990). The concise Oxford dictionary of literary terms, Oxford and N.Y., Oxford University Press.

[6] Newell, W. H. (2001) "A theory of interdisciplinary studies", Issues In Integrative Studies, *19*, 1-25.

[7] Frank, R. (1988). "Interdisciplinary": The first half-century.*Issues in Integrative Studies*,6, 139-151.

[8] Klein, J. T. (1996). *Crossing* Boundaries: Knowledge, disciplinarities, and interdisciplinarities. *Charlottesville* and London: University of Virginia Press.

[9] Menard, L. (2001). Undisciplined. *The Wilson Quarterly*, 25(4), 51-60.

[10] Newell, W.H., Hall, J., Hutkins, S., Larner, D., McGuckin, E., & Oates, K. (2003). Apollo meets Dionysius: Interdisciplinarity in long-standing interdisciplinary programs. *Issues in Integrative Studies*, 21, 9-41.

[11] Jacobs HH, Borland JH. (1986). The Interdisciplinary Concept Model—Theory and Practice. Gifted Child Quarterly; 30(4):159–63.

[12] Morillo F, Bordons M, Gomez I. (2003). Interdisciplinarity in Science: A Tentative Typology of Disciplines and Research Areas. Journal of the American Society for Information Science and Technology; 54:1237–49.

[13] National Academy of Sciences (2005). Facilitating Interdisciplinary Research.Washington, DC: The National Academic Press.

[14] Swoboda, W. W. (1979). Disciplines and Interdisciplinarity: A Historical Perspective. In Joseph. J. Kockelmans (Ed.), *lnterdisciplinarity and Higher Education (*pp. 49-92). University Park: The Pennsylvania State University Press

[15] Aram JD. (2004). Concepts of Interdisciplinarity:Configurations of Knowledge and Action. Human Relations.; 57(4):379–412.

[16] Frost SH, Jean PM. (2003). Bridging the Disciplines—Interdisciplinary Discourse and Faculty Scholarship. Journal of Higher Education.; 74(2):119–49.

[17] Matthew E. Edwards, (2014). Journal of Systemics, Cybernetics and Informatics, "Recognizing the Need for Rich Contextualization in the Classroom and Applying It With Modified Bloom's Cognitive Domain Taxonomy For Successful Teaching of Physics 106 (Physics II – electricity, magnetism, and Light), Vol. 12, No. 3.

[18] Siemann, U. (2005). "Solvent Cast Technology – A Versatile Tool for Thin Film Production," Progress Colloid Polymer Sci., 130, 1-14.

[19] Matthew Edwards, Stephen Egarievwe, Afef Janen, Tatiana Kukhtarev, Jemilia Polius, John Corda, (2014). "Temperature Dependent Surface Resistivity Measures Of Commercial, Multiwall Carbon Nanotubes (MWCNT), and Silver Nano-Particle Doped Polyvinyl Alcohol (PVA) Films", *Materials Sciences and Applications*, **5**, No. 13, 915-922.

[20] Quianna S. Johnson, Matthew Edwards, Michael Curley, (2013). "Analysis of the refractive index and film thickness of Eu doped gadolinium oxide (Gd_2O_3) planar waveguides fabricated by the sol-gel and dip coating methods", SPIE Vol. 8847, no 5.

[21] Simmons, Russell and Chris Morrow, (2014). "Success Through Stillness: Meditation Made Simple", Gotham Books, Penguin Group, New York.

[22] Clinton, Hillary Rodham, (2006). "It Takes A village" 10th anniversary edition, Simon and Schuster, New York.

A Philosophy of Learning

Jeremy HORNE
The Inventors Assistance League
Prescott, AZ USA
mindsurgeon@hotmail.com

ABSTRACT

The survival of the *homo sapiens sapiens* species depends upon learning and passing on to future generations quality knowledge. Yet, we find to an increasing extent a corruption of the process, resulting in ignorance, environmental destruction, and breakdown of community. A fundamental shift in priorities is required to avert disaster. Articulating a solution depends upon a language, which, in turn, depends upon clarifying concepts. This paper identifies the dialectical (something existing because of what it is not) interrelationship of episteme (theory) and techné (practice) within the framework of ethos, pathos, and logos. This structure and process as learning provides coherence in developing knowledge and can then be what in a generic sense is religion (to cohere, or bind). In a monk-like devotion to learning to generate quality knowledge humanity can appreciate its own meaning and make this world a better place in which to live. In this way religion becomes philosophy, and philosophy religion.

Keywords: Learning, Education, Knowledge, Philosophy of Education, Philosophy of Knowledge, Philosophy of Religion.

1. INTRODUCTION

If a survey of the literature on peer review is any indication of learning quality, the *homo sapiens sapiens* species is in trouble. Its ability to pass on knowledge is deeply compromised, and corrupted knowledge may affect the species' very existence. For example, if medical literature is fraught with inaccuracy about how to stem epidemics or treat various illnesses, whole populations face survivability issues. Yet, we see an emerging body of literature that suggests that not only is there corrupted information but the system charged with creating and passing on knowledge to future generations, itself is corrupted. To survive this species needs to value both the content and the vehicle carrying it. In particular, we are referring to the content of terms like "academics", "education", "training", "learning", "schooling", "knowledge" and related terms.

Set forth in this paper is the view that many people are ambiguous at best when they refer to these terms and that by a deeper understand of what they entail and a will to carry out their meaning as the content of learning, this species will have a better chance of carrying on. At one of the conceptual spectrum is "learning or learning's sake". At the other is learning for application, as in doing a task, where there is often a measurable outcome. We often talk about these ideas as if both our audience and we know what they are, but one should re-examine from where many get their understanding.

Use in the literature provides some context, but a common beginning is in our first exposure to new terms through various dictionaries and ostensible standards of usage. Yet, there is ambiguity in the terms like "education", and this creates disorder in the way we pass on to our offspring both our views on who we are and why we exist, as well as how we convey these ideas. Analogous to DNA replication, if a disruption occurs in the primary strand, the succeeding generations will be compromised. The problem occurs not so much in the content but the process, itself. Our ability to communicate depends upon being able to convey meaning through a consistent use of a word. That is, the content represented by that word must be the same from communication to communication and among all persons using that word. Evidence of consistent use is history, i.e., etymology, and for it I rely for my case that we often don't know what we are talking about when discussing what learning is, let alone its purpose or how we should go about doing it. Once the common thread of meaning has been identified, I will show that learning is a recursive process, where particular knowledge exists in terms of general knowledge, and vice versa. Once this is established we as humans may see learning (theory and practice) as a part of our being, the way we able able to survive by passing our ability to thrive and our essence to future generations. The thesis, then, is that our passion should be the desire to acquire knowledge and convey it to others, but we have to know what we are talking about before this happens.

2. ORIENTING OURSELVES TO THE CONTENT OF WORDS

The object of learning is knowledge, but what is knowledge and how is it obtained? (Note that knowledge quality depends upon epistemology, or how we know something. Philosophers call it "justified belief". Exploring the details is a discussion related to but separate from the immediate scope of this paper.) It is often said (dictionaries being evidence) that gaining knowledge is through "education", as in "information, understanding, or a skill that you get from experience or education". One refers to "...a familiarity, awareness or understanding of someone or something, such as facts, information, descriptions, or skills, which is acquired through experience or education" [1], and "Facts, information, and skills acquired by a person through experience or education;" [2], "education" being a common operative word.

Yet, education is only one aspect of learning. [3]. Why?

"Education" variously defined is:

> the process of receiving or giving systematic instruction, especially at a school or university. [4]
>
> the action or process of teaching someone especially in a school, college, or university
>
> the knowledge, skill, and understanding that you get from attending a school, college, or university
>
> a field of study that deals with the methods and problems of teaching [5]
>
> The process of receiving or giving systematic instruction, especially at a school or university: *a new system of public education* [6].

The common denominator of these mainline sources is the word "process", that process being teaching, or instruction. That which is being taught is less defined, the second definition talking about "knowledge, skill, and understanding ". The Oxford dictionary refers to "A body of knowledge acquired while being educated: *his education is encyclopedic and eclectic" and* "information

about or training in a particular field or subject". The words "training" and "skill" suggest an identifiable field of information that can be passed from person to person with little or no change of content. Yet, there appears to be missing an answer to how this information is developed. In searching for and scrutinizing associated words for an answer, we see "academic" and its derivatives, "academic" variously defined as:

> usually used before a noun : of or relating to schools and education
> having no practical importance : not involving or relating to anything real or practical
>
> a person who is a teacher in a college or university [7]
>
> adjective
> 1. of or pertaining to a college, academy, school, or other educational institution, especially one for higher education:
> academic requirements.
> 2. pertaining to areas of study that are not primarily vocational or applied, as the humanities or pure mathematics.
> 3. theoretical or hypothetical; not practical, realistic, or directly useful:
> an academic question; an academic discussion of a matter already decided.
> 4. learned or scholarly but lacking in worldliness, common sense, or practicality.
> 5. conforming to set rules, standards, or traditions; conventional:
> academic painting.
> 6. acquired by formal education, especially at a college or university:
> academic preparation for the ministry.
> 7. (initial capital letter) of or pertaining to Academe or to the Platonic school of philosophy. [8]
>
> Of or relating to education and scholarship:
> Of or relating to an educational or scholarly institution or environment: *students resplendent in academic dress*
>
> 1.2(Of an institution or a course of study) placing a greater emphasis on reading and study than on technical or practical work: *an academic high school that prepares students for the best colleges and universities*. [9]

The commonality here is that "academic" refers to education occurring within the confines of a structure, such as a set of rules, institution, or school. We are at full circle, save for the reference to " theoretical or hypothetical", a breakaway from the persistent reference to "education", or a well-defined set of information. Perhaps by looking at the customary usage throughout recent history (i.e., the etymology) we may see why there is this persistence.

Education as a process occurs within a framework or environment of what we call "academia". To adhere to a consistent, hence historical use of the term, we turn to the etymology, "education" being:

> "A breeding, a bringing up, a rearing") from *ēdūcō* ("I educate, I train") which is related to the homonym *ēdūcō* ("I lead forth, I take out; I raise up, I erect") from *ē-* ("from, out of") and *dūcō ("I lead, I conduct")"* [10]

Within this history one finds the seeds of a debate about the nature of that leading, or conducting, and the very nature of that leading, itself. An analysis of this etymology focuses upon:

- breeding, bringing up, rearing
- training
- erect
- lead.

One may picture a scenario – not unlike that depicted in the novel *Brave New World* - the manufacture of humans, standing them up like robots, infusing them with a circumscribed set of facts and procedures, pulling them off an assembly line, and shoving them forward to perform their programmed routine. Given this post-industrial world, such is not surprising. In the *Brave New World* philosophy was discouraged, as free thinking was regarded as disruptive and straying from the regularity of a regimented (albeit ostensibly stable) society. Not much in the etymology of "education" allows for the individual to explore on her or his own the world and discover truths for that individual's benefit. Rather, a leader infuses the person with information (training) to then be in turn transferred to successors. Keeping such a view of education in mind, we now turn to the context in which "education" occurs, academia.

Historically, "academia" means:

> 1580s, "relating to an academy," also "collegiate, scholarly," from Latin academicus "of the Academy," from academia (see academy). Meaning "theoretical, not practical, not leading to a decision" (such as university debates or classroom legal exercises) is from 1886. [11]

One can see the radically two different situations here. The first, "education" emphasizes a particular, training, the identification and conveying of particular information, or etymologically, "to train" meaning:

> "to discipline, teach, bring to a desired state by means of instruction," 1540s, probably from earlier sense of "draw out and manipulate in order to bring to a desired form" (late 14c.), specifically of the growth of branches, vines, etc. from mid-15c.; from train (n.). [12]

The key words are "desired form", referring to a specified end, rather than one being exploration and indefinite.

On the other hand, the etymology of "academic", the framework holding the conveying of specific information in "education" is "..."theoretical, not practical, not leading to a decision" ". Hence, "education" occurring in the "academic" world means having a person acquire specific information in an open-ended manner, i.e., without restriction.

One may argue that the survival of a species rests on the ability to pass to offspring the lessons learned in surviving this planet's environment. *Homo sapiens sapiens* is included, but a central difference between us and the rest of the species is how we regard the process and our ability to characterize its direction. An animal may find in the environment an object to be used as a tool, but the human will be able to identify what is need to be done, and not only design, make, and use that tool, but explain the theory of its design and operation. The following presentation occurs within this relationship between the education regarded as training and the structure holding it, academe.

3. THE NATURE OF OURSELVES BEING EDUCATED AND TRAINED

A central difference between animals and plants is the ability to abstract and apply that abstraction. Even insects, such as ants [13], have the capacity to store information and to anticipate, as

they collect food for their nests. Various species react to threats, "knowing" the consequences of not doing so. As species become more complicated on an evolutionary scale, these processes become more sophisticated. With the simple species, we speak of basic biological structures, such as ganglia; in the complex ones, there are brains, but other structures, such as dendrites and astrocytes may be involved as repositories and processors of information [14]. There is a danger, however, of identifying a physical structure storing and processing information and the information, itself, resulting in the classical debate about a mind being apart from a body, " "I," that is to say, the mind by which I am what I am, is wholly distinct from the body" [15].

An extensive discussion can emerge about why episteme is "food for the mind" and techné "food for the body" – satisfying physical needs), but , for the purposes of this paper, it argued that learning involves both. It is not on this ground that the argument is primarily made, but that each relies on the other for its existence and both as a "package" constitute the substance of learning. Such has implications for what occurs in the academic arena.

4. THE FRAMEWORK WITHIN WHICH LEARNING OCCURS

Our species attempts to perpetuate itself, either "innately" or by desire. For us, at least – *homo sapiens sapiens* – there seems to be for the most part a need for improvement, that need being translated into the process of learning. Humans must care enough about themselves to love knowledge because they recognize they need it to survive. Ignoring that need is suicidal. In mature cases, this knowledge is wisdom, the essence of philosophy. Indeed, to deny such means denying that we are sapiens, those who are "wise" [16]. "I ask if there is a passion (feeling, or pathos) to continue our being. The direction to which the acquisition of knowledge (and wisdom) and its application leads is through the word, content bearer, or logos. The reason why is ethos.

More formally, we can articulate:

- **Ethos** : credibility in the process of communication
- **Pathos**: adequate emotions in the process of communication and motivation for information and knowledge sharing
- **Logos**: via technical and natural language, as well as the use of adequate Logics [17]

In keeping with our method of discerning meaning, as described above, we examine the etymology of each of these terms.

Ethos

Etymologically, ethos is:

ethos (n.)

> "the 'genius' of a people, characteristic spirit of a time and place," 1851 (Palgrave) from Greek ethos "habitual character and disposition; moral character; habit, custom; an accustomed place," in plural, "manners," from suffixed form of PIE root *s(w)e- third person pronoun and reflexive (see idiom). An important concept in Aristotle (as in "Rhetoric" II xii-xiv). [18]

> **Ethos** (/ˈiːθɒs/ or US /ˈiːθoʊs/) is a Greek word meaning "character" that is used to describe the guiding beliefs or ideals that characterize a community, nation, or ideology. [19]

> One may regard Ethos as referring to the "credibility in the process of communication", "credibility" etymologically being "credo", or truth. This stems from the Greek idea of virtue, or – from veritas, or true. [20]

Pathos

pathos (n.)

> "quality that arouses pity or sorrow," 1660s, from Greek pathos "suffering, feeling, emotion, calamity," literally "what befalls one," related to paskhein "to suffer," and penthos "grief, sorrow;" from PIE root *kwent(h)- "to suffer, endure" (cognates: Old Irish cessaim "I suffer," Lithuanian kenčiu "to suffer," pakanta "patience"). [21]

Logos

logos (n.)

> 1580s, Logos, "the divine Word, second person of the Christian Trinity," from Greek logos "word, speech, discourse," also "reason," from PIE root *leg- "to collect" (with derivatives meaning "to speak," on notion of "to pick out words;" see lecture (n.)); used by Neo-Platonists in various metaphysical and theological senses and picked up by New Testament writers. [22]

Each of the ensemble of ethos, pathos, and logos works dialectically to produce the whole: one motivated (pathos) with the truth of the desire for learning (ethos) and communicating (logos) to other members of the species.

Recall that etymologically, education (training) occurs within the framework of the academic (learning without a specific objective – learning for learning's sake).

5. THE CONTENTS CONTAINED BY THE FRAMEWORK

We return from the discussion about the interrelationship between academics and education, the former as theory and the latter as practice, each existing because of the other. The etymology of the constituents of learning: episteme and techné.

Episteme

> ...etymologically derived from the Ancient Greek word ἐπιστήμη for knowledge or science, which comes from the verb ἐπίσταμαι, "to know". In Plato's terminology episteme means knowledge, as in "justified true belief", in contrast to doxa, common belief or opinion. The word epistemology, meaning the study of knowledge, is derived from episteme. [23]

Techné

"...etymologically derived from the Greek word τέχνη (Ancient Greek: [tékʰnɛː], Modern Greek: [ˈtexni] (listen)), that is often translated as "craftsmanship", "craft", or "art"." [24]

"Episteme" pertains to theory and techné to practice, an example being science as theory and technology as practice. Episteme is synthesis; techné is analysis. Synthesis is the bringing together disparate ideas by a means unknown to us to form a new idea. Analysis is the breaking down of a whole into its constituent parts. From a logical standpoint, the former is inductive, the latter deductive. Induction yields conclusions that are not certain, because we cannot account for how we form the premises from which we draw the conclusions. With deduction we can identify in a specific way the premises on which a conclusion is based. Neither induction nor deduction is by itself sufficient to

apprehend the meaning of anything. Each exists because of the other dynamically.

6. THE MOST FUNDAMENTAL LAW OF PROCESS

We arrive at what appears to be two polar opposites – theory and practice, or episteme and techné operating within the framework of ethos, pathos, and logos. To derive any concept of these relating to each other, there has to be process. Ancient accounts of the two, such as by Plato, have philosophers seeming to use the two interchangeably [25]. "Theory" is a concept relating to the general, and "practice" refers to specifics. For an application, one needs a theory, but for a theory to have any relevance to a present situation, there needs to be an application to give the theory a worldly meaning. There is a philosophical foundation that describes this relationship of one existing because of the other: dialectics. There is a physical reason for dialectics.

One may picture her/himself in a room that is entirely of the same color of blue. Visually the person will not be able to discern one object from another. Other senses, such as touch, sound, or smell may detect those objects, however, meaning that on a fundamental level it takes differentiation to allow us to detect anything.

Something exists by virtue of what it is not; theory exists because of practice, and practice exists because of theory. One entity is in terms of another, and this "back and forth" way of understanding is a process, the dialectic process. Learning, then, is the process by which a motivated (pathos) individual desires as the best this species has to offer (ethos): to communicate (logos) knowledge as theory (episteme) in terms of (dialectics) practice (techne) and vice versa.

7. WHAT LEARNING FACES

The world of learning is at a critical juncture. Learning is not only for its own sake, but the way we apply it will determine whether we can address problems like environmental degradation, overpopulation, and resource allocation, all challenges to our species, itself. One can argue successfully that learning has become denigrated, priorities being in other areas. Classroom sizes, curriculum content, funding for education, and the desire for learning for its own sake are considerations secondary to paying sports figures millions of dollars, "entertainment", and purchasing superfluous consumer items. The paucity of basic knowledge is reflected in figures reflecting scientific illiteracy [26] and reading deficiencies, where "50% of adults cannot read a book written at an eighth grade level" [27].

The status of peer review is symptomatic of a species in trouble. Fang et all reported in 2012 that "67.4% of retractions were attributable to misconduct" [28]. Fraud, data manipulation, and plagiarism are major factors, and the pressure by academics to publish contributes, as well. The inclination to produce quality knowledge is secondary. In manuscript preparation, there are numerous freelance writing websites that offer customized research papers for students to pass in as their own assignments for courses. An Internet search under "purchase term papers" and related phrases yields numerous websites, such as "Buy Research Paper Online | 100% Original | Professional ", "Buy Essay & Research Paper Online, Custom Essay Writing ...", and "Buy College Essays, Custom Term Papers", this last one advertising "High quality custom essays crafted by real unemployed professors [29]." The fraud and plagiarism doe not stop at purchasing manuscripts. Diploma mills are a standard route to obtaining a graduate degree, one case merely requiring the purchaser to "Take a test" [30].

If there is not a prioritization of learning, how can it be expected that there will be quality peer review? Sustaining knowledge quality is not first on the list of priorities in the US. Clearly, there has be a re-ordering of what is important.

8. LEARNING AS RELIGION

In tying together all of what we said, pathos is that motivation behind humanity taking a high road ethos to figuratively speak the word of knowledge. From within a person is the emotion, the motivation that impels her or him to express via the word an ethos. Ethos (the values – what is important) is "generated" from the pathos (the being inside us, the motivation, the drive) via the word (logos, or process – remembering the dialectic between the concepts the word conveys – episteme and techné). Pathos, is the state of mind, the motivation for acting as a species differentiated from the rest, as stated above, " our the process and our ability to characterize its direction". One last question remains about what the philosophy of learning entails.

This is not an appeal for persons to be religious – at least in a popular sense. However, inasmuch as the vast majority of the population are believers in a religious ideology [31], it would seem reasonable to introduce the love of wisdom as an unshakable value system. These figures reflect a growing uneasiness that the traditional ideologies are not satisfying answers to what the meaning of life entails. Ideologies as systems of ideas provide coherence. In its broader sense, religion is about coherence, as the etymology indicates.

> ...(from O.Fr. religion "religious community," from L. religionem (nom. religio) "respect for what is sacred, reverence for the gods," "obligation, the bond between man and the gods") is derived from the Latin religiō... One possibility is an interpretation traced to ...Tom Harpur and Joseph Campbell favor the derivation from ligare "bind, connect", probably from a prefixed re-ligare, i.e. re (again) + ligare or "to reconnect," which was made prominent by St. Augustine, following the interpretation of Lactantius. [32]

This approach allows for a transition from a reverence of rigid set of ideas to a reverence of the process of attaining knowledge. It has not been a focus of this paper, but no less important is the quality of knowledge, or what philosophers call "epistemology", justified belief. Western history provides a model of one engaged in this process.

One may often regard the Medieval monk cloistered in a monastery praying daily and living the life of an ascetic. While this may be true, such is only a superficial description. A monk was a devoted person, again, superficially committed to the content of Christian scriptures, but underlying this behavior was a devotion to something more profound – attempting to discern meaning, or coherence in life. It was an attitude, a way of being in the world. Rather than orienting life's activities to acquiring material things, there was a sense of living outside this world. A similarity exists in South Asian religions, where Hinduism and Buddhism reject the importance of the material life and focus on what is more lasting, variously referred to as "Nirvana", "karma", "the one", and so forth. It matters little about a particular description, merely the scope of focus – long, as opposed to short term. What religion concerned was understanding not only one's core (the particular), but the context in which that core rests (the general), the relation being a reflection of that innate structure about which we have been observing through our whole discussion. Learning (the dialectic between the academic and education, if we are to adhere to the

etymology, has as its pathos the desire for coherence, its ethos as virtue (being the best that we are capable of doing as humans – learning about meaning), and the logos (conveying knowledge) – in coming full cybernetic cycle - as telling the species that our very being is about our need to learn.

9. CONCLUSIONS

A pattern of arrangements has emerged in all this, one analogous to induction-deduction, the particular in terms of the general, the one contradistinguished from everything else. Often, apparently disparate ideas coalesce into a single observation about life overall. Such argues for innate structures and accompanying processes permeating our world. For example, ancient philosophers in South Asia identified 4500 years ago in The *Creation* hymn in the *Rig Veda*, "Whence all creation had its origin, he, whether he fashioned it or whether he did not, he, who surveys it all from highest heaven, he knows--or maybe even he does not know. [33]" For Samkhya, the oldest form of Hinduism, the soul (purusha) is counterpoised against matter (prakriti), one in terms of the other; neither has it own identity in isolation**.** In the West, it is the dualism of mind and matter. In the Samkhy philosophy, everything started with an eternal unconscious as the universe and from it unfolded everything we have today. A modern version is the Universe emanating from the singularity. From a whole emerges diversity, a law of cosmic order (*rta)*, according to the *Rig Veda*. In the Vedic view [34], creation comes from the self-consciousness of the primeval being (Purusha) that modern philosophers of consciousness could equate with the Universe, the Universe, itself, being conscious [35].

A world emerging from the inchoate also is told of in ancient Western philosophy. Hesiod (ca. 750 and 650 BCE) wrote of everything being born of chaos [36]. Others, such as Anaximander (c.610—546 BCE), stated, "...some other nature which is indefinite, out of which come to be all the heavens and the worlds in them.[37]" Lucretius (ca. 99 BC – ca. 55 BC) said that without differentiation there could be no harmony, i.e,:

> In that long-ago
> The wheel of the sun could nowhere be discerned
> Flying far up with its abounding blaze,
> Nor constellations of the mighty world,
> Nor ocean, nor heaven, nor even earth nor air.
> Nor aught of things like unto things of ours
> Could then be seen--but only some strange storm
> And a prodigious hurly-burly mass
> Compounded of all kinds of primal germs,
> Whose battling discords in disorder kept
> Interstices, and paths, coherencies,
> And weights, and blows, encounterings, and motions,
> *Because, by reason of their forms unlike*
> *And varied shapes, they could not all thuswise*
> *Remain conjoined nor harmoniously*
> *Have interplay of movements.* But from there
> Portions began to fly asunder, and like
> With like to join, and to block out a world,
> And to divide its members and dispose
> Its mightier parts--that is, to set secure
> The lofty heavens from the lands, and cause
> The sea to spread with waters separate,
> And fires of ether separate and pure
> Likewise to congregate apart [38]. (emphasis added)

This most fundamental relationship is the unity of everything. It is what the ancients realized, and modern scientists realize it, as well. Once that realization is attained, there remains only an inner calmness.

12. REFERENCES

(All websites accessed 4-5 December 2014 – title of entry found within URL)

[1] http://www.merriam-webster.com/dictionary/knowledge
[2] http://www.oxforddictionaries.com/us/definition/american_english/knowledge
[3] http://en.wikipedia.org/wiki/Learning, http://www.merriam-webster.com/dictionary/learning
[4] https://www.google.com/search?client=ubuntu&channel=fs&q=definition+of+education&ie=utf-8&oe=utf-8
[5] http://www.merriam-webster.com/dictionary/education
[6] http://www.oxforddictionaries.com/us/definition/american_english/education
[7] http://www.learnersdictionary.com/definition/academic
[8] http://dictionary.reference.com/browse/academic
[9] http://www.oxforddictionaries.com/us/definition/american_english/academic
[10] http://www.etymonline.com/index.php?term=educate
[11] http://www.etymonline.com/index.php?allowed_in_frame=0&search=academia&searchmode=none
[12] http://www.etymonline.com/index.php?term=train
[13] http://en.wikipedia.org/wiki/E._O._Wilson
[14] http://www.cell.com/neuron/abstract/S0896-6273%2814%2900688-6 http://www.columbia.edu/cu/psychology/courses/1010/mangels/neuro/neurocells/neurocells.html http://www.human-memory.net/brain_neurons.html , http://en.wikipedia.org/wiki/Body_memory
[15] R. Descartes, **The Method, Meditations, and Philosophy**, "Discourse on Method,"Part II, p. 122, http://oll.libertyfund.org/?option=com_staticxt&staticfile=show.php%3Ftitle=1698&Itemid=27
[16] http://www.etymonline.com/index.php?term=sapient
[17] N. Callaos, http://www.iiis.org/ViewVideo2014.asp?id=4
[18] http://www.etymonline.com/index.php?term=ethos
[19] http://en.wikipedia.org/wiki/Ethos
[20] http://en.wikipedia.org/wiki/Truth
[21] http://en.wikipedia.org/wiki/Truth
[22] http://www.etymonline.com/index.php?term=logos
[23] http://en.wikipedia.org/wiki/Episteme
[24] http://en.wikipedia.org/wiki/Techne
[25] http://plato.stanford.edu/entries/episteme-techne/
[26] http://www.nsf.gov/statistics/seind04/c7/c7s2.htm
[27] http://literacyprojectfoundation.org/community/statistics/
[28] http://www.pnas.org/content/109/42/17028.abstract
[29] https://www.google.com/search?client=ubuntu&channel=fs&q=purchase+term+papers&ie=utf-8&oe=utf-8
[30] http://calsuni.com/order.php
[31] http://www.harrisinteractive.com/NewsRoom/HarrisPolls/tabid/447/ctl/ReadCustom%20Default/mid/1508/ArticleId/1353/Default.aspx
[32] http://en.wikipedia.org/wiki/Religion#Etymology
[33] **Rig Veda**, Hymn CXXIX – Creation, Book the Tenth.
[34] **Rig Veda** – Oxford Companion to Philosophy, http://www.answers.com/topic/ancient-philosophy#Indian_philosophy
[35] M. Kafatos and R. Nadeau, **The Conscious Universe**, New York: Springer-Verlag, 1999.
[36] Hesiod, **Theogeny**, Line 116.
[37] Simplicius, **Commentary on Aristotle's Physics** (24.13-21), Aristotle, Physics VI:9, 239b5.
[38] Lucretius, **The Nature of Things**, "Formation Of The World and Astronomical Questions".

Editorial Purpose, Strategy and Methodology

Journal of Systemics, Cybernetics and Informatics: JSCI

(www.iiisci.org/Journal/SCI)

As it was emphasized in the editorial of the first issue, the main purpose of the Journal is to collaborate in the **systemization** of knowledge and experience generated in the areas of Systemics, Cybernetics (communication and control) and Informatics. This systemization process necessarily implies a progressive increase and enlargement of the **relatedness** among the associated areas, as well as among their respective disciplines. So, improvement in **interdisciplinary communication** would provide a very good support for the sought systemization process. This is one of the main objectives of the Journal we are launching with this first issue, and our editorial policy will be directed by it.

We are trying to support the process of interdisciplinary communication among and in the areas included in Systemics, Cybernetics and Informatics, by means of 1) providing a **multidisciplinary forum** in the related areas, 2) fostering **interdisciplinary research** in them, 3) publishing papers related to transdisciplinary concepts, allowing different disciplinary perspectives on the same concept, and 4) encouraging communication among disciplines by means of **interdisciplinary tutorials**, and among the academic, the public and the private sectors by means of publishing information related **multi- and inter-disciplinary** projects which involve at least two of them.

In the context of this main purpose, a basic immediate objective of the Journal is to provide a multidisciplinary vehicle for disseminating information about diverse but highly interrelated areas through a single medium. It covers a wide range of areas, sub-areas and topics related to Systems Science, Engineering and Philosophy (Systemics), Communications and Control of Mechanisms and Organisms (Cybernetics) and Computer Science and Engineering, along with Information Technologies (Informatics).

These three major areas are continuously evolving into integrative means of diverse disciplines. Informatics supports **instrumental** multi- and inter-disciplinarity. Cybernetics showed to be fruitful for **conceptual** inter-diciplinarity and for analogy generation and cross-fertilization between mechanisms and organisms, in order to improve our understanding of organic systems, to enhance our designs of mechanical systems and to inspire the conceptualizations and the production of hybrid systems, as it is the case of cyborgs. Systemics has been viewed by an increasing number of authors as one of the most fundamental **trans-disciplines**. Consequently, each one of these three major areas has been providing an increasing support for multidisciplinary problem solving research and for interdisciplinary communications and integrations among different academic disciplines and among academic, industrial and governmental organizations.

Therefore, the basic aims of this Journal are

1. To support **multidisciplinary** information dissemination related to different disciplines in the major areas of Systemics, Cybernetics and Informatics (SC&I).
2. To foster **interdisciplinary communication** based on the integrative potential of these three major areas. Accordingly, the journal will include not just areas from SC&I, but also from the relationships among them, among their areas and sub-areas and between them and disciplines from other areas, especially in the form of applications of SC&I disciplines in other disciplines, and vice versa. Consequently, a strong emphasis is made on relationship areas and on what has been named as hyphened sciences, engineering and technologies, in order to refer to the inter-disciplines that are emerging as a consequence of multi- and inter-disciplinary problem-centered research.
3. To support inter-organizational multi- and inter-disciplinarity among academy, industry and government.

The Journal will initially have a multidisciplinary orientation. Interdisciplinary and transdisciplinary sections will gradually grow. The multidisciplinary part of the Journal will be nourished, basically, from the best papers presented in conferences in the Journal's areas, basically from the conferences or workshops organized by The International Institute of Informatics and Systemics (IIIS). The best 5-10 % of the papers presented at IIIS's conferences will be among the papers accepted for publication, after their respective authors had made the respective modifications and extensions pertinent to archiving and journals.

Consequently, with this approach, we are hoping to produce a very high quality journal, because its basic content will be related to the 5-10 % best papers presented in related conferences, which is the **equivalent**, though not exactly the same, of a rate of, at least, 90% of refusal. This way of achieving a high quality Journal, will not be based on a high number of actual refusals. With this strategy we will be avoiding being the cause of the hidden psychological and economical costs caused to the authors of refused papers. The greater the refusal rate, the greater the hidden costs caused, by the editors, to potential authors of refused papers by the editors. We are hoping, with our **editorial strategy** to minimize the hidden costs we might be causing by means of our editorial decision, while not compromising the journal high quality.

Our **methodological strategy** will be a **systemic**, not a **systematic** one. To organize the editorial process and to manage the publishing operational activities will be done with an **open**, **elastic**, **adaptable** and **evolutionary** methodological system. It will have the **flexibility** required to adapt the Journal, its editorial policy, its organizational process and its management to the dynamics of its related areas and disciplines, to changes produced by the inherent learning process involved, and to the uncertainty of the environment.

Information to Contributors

Journal of Systemics, Cybernetics and Informatics: JSCI

(www.iiisci.org/Journal/SCI)

Editorial Policy

The Journal of Systemics, Cybernetics and Informatics (JSCI) publish a wide range of papers related to original research, applications and advanced technologies, as well as to reports on technological innovations, designing methodologies and successful consulting experiences. *JSCI* is a multidisciplinary publication with an editorial policy oriented to encourage disciplinary focused publications, as well as inter-disciplinary and trans-disciplinary articles in the context of Systemics, cybernetics and Informatics. The main purpose of *JSCI* is to serve as a platform for interdisciplinary communications in its areas of interests, and especially in the **relationships** among these areas. The scope of *JSCI* comprehends a wide range of areas, sub-areas and topics which are presented in the electronic version of the journal.

Submission of Manuscripts for Review

Papers for review should be submitted via email (sci-journal@iiis.org). Later, submissions should be made online, via a Web form. A contact author name, e-mails, phone number, etc. should also be sent via the web form. If the paper has co-authors, their respective names would be added in the camera ready version, if the paper is accepted for publication. All papers should contain at least a sufficiently informative abstract of about 100-200 words (where nature and significance of the paper should clearly be stated), keywords, Introduction of the paper and bibliography. Papers should be written in English. Authors whose English language is not their own are certainly requested to have their manuscripts checked (or co-authored) by an English native speaker, for linguistic correctness before submission. Editorial decisions on acceptance or otherwise will be taken normally within three months of receipt of a paper. In some cases as, for example, where more reviewers will be requires, because there are significant differences in the evaluations of the initially assigned reviewers, editorial decisions may take up to six months.

JSCI manuscripts maximum length is 25 double-spaced pages, single column (including figures and references). This is approximately equivalent to 6000 words. The final manuscripts submitted for publications of accepted papers have a maximum length of 12 single-spaced double-column pages, according 12 formatted *JSCI* pages. Any page or fraction thereof surpassing this limit is charged $100. Regular papers may not exceed 20 pages, in any case. Instructions to authors whose papers has been accepted for publication will be sent to them simultaneously with the acceptance notice.

Copyright Information

Articles accepted for publication will become property of the Publisher and may not be reprinted or translated without the written permission of the Publisher. Some organizational restrictions will be considered on specific cases.

It is understood that the content of papers sent for their respective review have been neither submitted to other publication, nor published in, another journal. Simultaneous submission to *JSCI* and other publication (s) is considered a serious breach of ethics and, if it is detected, will have the effect of immediate rejection of the submission, without excluding other actions that might be taken.

Papers previously published in preprints, internal publications, proceedings, etc. are eligible for their reviews, as long as they have gone substantial revisions, the editor-in-chief has been explicitly informed and possible copyright clearances have been obtained by the paper author.

The author is responsible for obtaining corporate and security clearances and copyright releases prior to sending material for its consideration or reviewing. It is *JSCI*'s policy to assume all clearances are granted and possible copyrights are transferred when a paper is submitted for its review.

Subscription details

Subscription rates per volume (6 issues per volume) are the following:

- Institutional rates: USA $480 for USA/Canada and USA $540 for the rest of the world
- Personal rates: USA $120 for USA/Canada and USA $140 for the rest of the world

Back issues have the same rate.

Subscriptions inquiries, and address changes or corrections, may be made via e-mail: sci-journal@iiis.org or via Fax: +1 (407) 656-3516

Copyright and Reprints

All materials contained in this publication are property of *The International Institute of Informatics and Systemics (IIIS). IIIS* grants reproduction rights to libraries, researchers and teachers, for scholarly personal use, provided that no fee for the use or possession of such copies is charged to the ultimate consumer of the copies.

Articles reprints may be obtained at a rate of
$1 per page for the first 10 reprints,
$0.75 per page, for 10-50 reprints, and
$0.50 per page for more than 50 reprints;
plus shipping and handling costs.

Authors, and co-authors, will have a discount of 50% in the reprints' rate. They also may ask for 40 free reprints of their articles, if their respective organization is a *JSCI's* subscriber; or they can as ask for 20 free reprints if the author, or any of the co-authors, is a *JSCI*'s subscriber. In such a case, just the person subscribed to the journal may ask for these free reprints.

Disclaimer

The Editors and the Publisher of the International Journal of Systemics, Cybernetics and Informatics, are not responsible for the scientific content and statement of the authors of accepted papers.