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AN EXTENDED MODEL OF ADOPTION OF TECHNOLOGY IN HOUSEHOLDS: A MODEL TEST ON PEOPLE'S INTENTION TO ADOPT A MOBILE PHONE

Gérard Fillion, University of Moncton
Sylvie Berthelot, University of Moncton
gerard.fillion@umoncton.ca

ABSTRACT

Individual adoption of technology has been studied extensively in the workplace (Brown & Venkatesh, 2005). Far less attention has been paid to adoption of technology in the household (Brown & Venkatesh, 2005). Obviously, mobile phone is now integrated into our daily life. Indeed, according to the more recent forecast of Gartner Research, 986 millions of mobile phones have been sold throughout the world in 2006 (Ouellet, 2006). And, as the tendency is showing up, mobile phone use will be continuously increasing in the future. The purpose of this study is then to investigate who has the intention to adopt a mobile phone, and why? In other words, we try to identify who really wants to buy a mobile phone and what are the determining factors who will make such that he/she will buy it? On the basis of the theoretical foundations developed by Brown and Venkatesh (2005) to verify the determining factors in intention to adopt a computer in household by American people, this study examines the determining factors in intention to buy a mobile phone in household by Canadian people. Data were gathered from 307 Atlantic Canadian people who do not yet own a mobile phone. Data analysis was performed using the structural equation modeling software Partial Least Squares (PLS). The results revealed that only one third of the variables examined in the study showed to be determining factors in intention to buy a mobile phone for household use.

INTRODUCTION

Since numerous years, mobile phone is used for different professional purposes, particularly by senior managers in the workplace. And this technology is more and more used in the workplace since mobile applications have been integrated to actual enterprise business strategies. Individual adoption of technology has been studied extensively in the workplace (Brown & Venkatesh, 2005). Far less attention has been paid to adoption of technology in the household (Brown & Venkatesh, 2005). Obviously, mobile phone is now integrated into our daily life. According to the more recent forecast of Gartner Research, 986 millions of mobile phones have been sold throughout the world in 2006 (Ouellet, 2006). And, as the tendency is showing up, mobile phone use will be continuously increasing in the future. The purpose of this study is then to investigate who has the intention to adopt a mobile phone for household use, and why? In other words, we try to identify who really wants to buy a mobile phone for household use and what are the determining factors who make such that he/she will buy it?

Few studies have been conducted until now which investigate the intention to adopt a mobile phone by people in household (in the case of those who do not yet own a mobile phone) or the use of mobile phone in the daily life of people in household (in the case of those who own a mobile phone). Yet, we can easily see that mobile phone is actually completely transforming the ways of communication of people around the world. It is therefore crucial to more deeply examine the determining factors in intention to buy a mobile phone by people in household. This is the aim of the present study. The related literature on the actual research area of mobile phone is presented in the full version of the paper.

As we can see in the summary of literature related to mobile phone presented above, few studies until now examined the determining factors in intention to adopt a mobile phone by people in household. Thus, the present study brings an important contribution to fill this gap as it allows a better understanding of the impacts of mobile phone use in people's daily life. It focuses on the following two research questions: (1) Who are the potential buyers of a mobile phone for household use? and (2) What are the determining factors in intention to buy a mobile phone for household use?

The paper builds on a framework suggested by Fillion (2004) in the conduct of hypothetico-deductive scientific research in organizational sciences, and it is structured as follows: first, the theoretical approach which guides the study is developed; second, the methodology followed to conduct the study is described; and finally, the results of the study are reported and discussed.

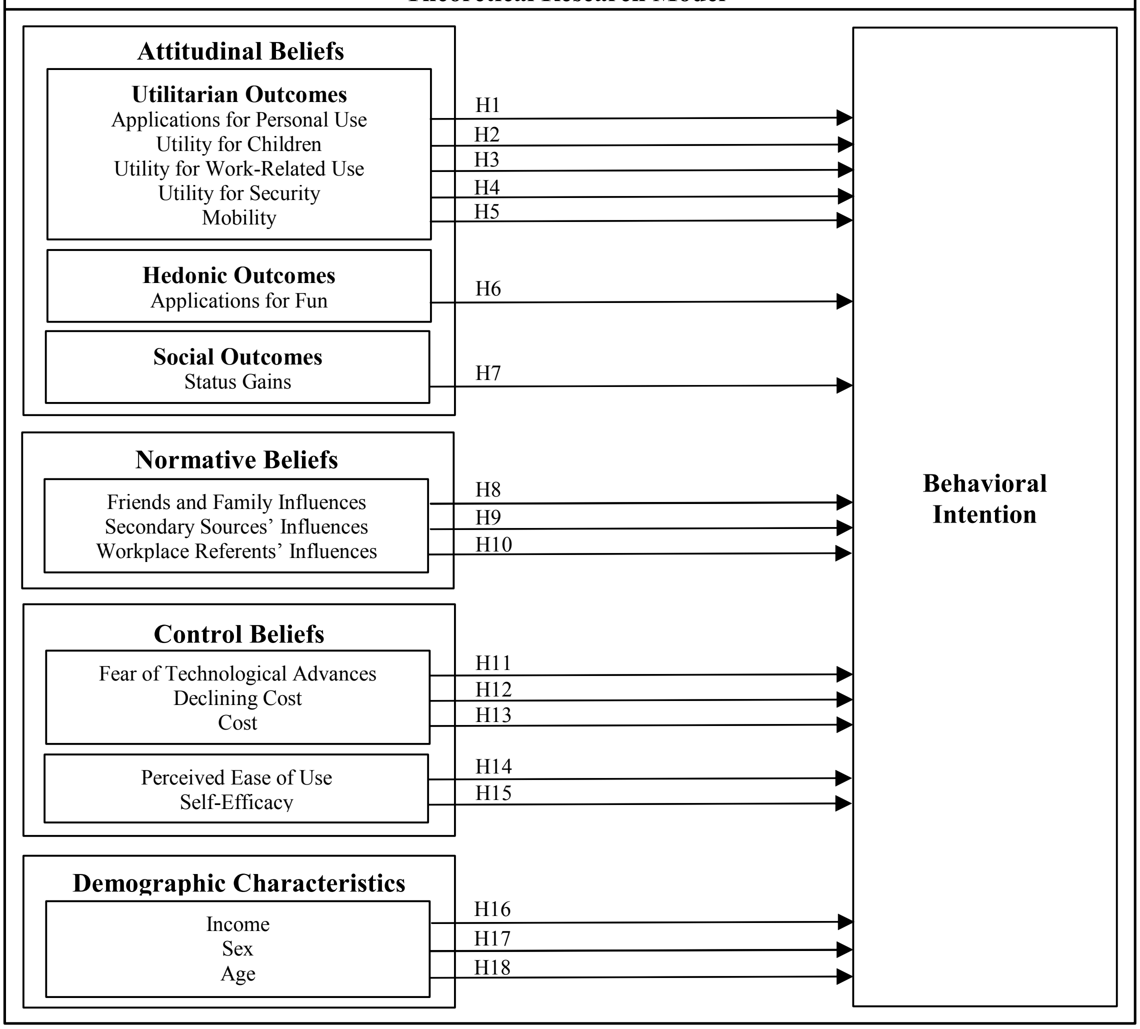
THEORETICAL APPROACH

This study is based on the theoretical foundations developed by Venkatesh and Brown (2001) to investigate the factors driving personal computer adoption in American homes as well as those developed by Brown and Venkatesh (2005) to verify the determining factors in intention to adopt a personal computer in household by American people. In fact, Brown and Venkatesh (2005) performed the first quantitative test of the recently developed model of adoption of technology in households (MATH) and they proposed and tested a theoretical extension of MATH integrating some demographic characteristics varying across different life cycle stages (see Danko & Schaninger, 1990) as moderating variables. With the exception of marital status (we included sex instead), all the variables proposed and tested by Brown and Venkatesh (2005) are used in this study, but none of them is tested as moderating variable. And we also added two new variables in order to verify whether people are thinking that mobile phone might be used for security and mobility. The resulting theoretical research model is depicted in Figure 1.

Figure 1 shows that Brown and Venkatesh (2005) integrated MATH and Household Life Cycle in the following way. MATH presents five attitudinal beliefs grouped into three sets of outcomes: *utilitarian*, *hedonic*, and *social*. Utilitarian beliefs are most consistent with those found in the workplace and can be divided into beliefs related to *personal use*, *children*, and *work* (we added beliefs related to *security* and *mobility*). The extension of MATH suggested and tested by Brown and Venkatesh (2005) presents three normative beliefs: *influence of friends and family*, *secondary sources*, and *workplace referents*. As for control beliefs, they are represented in MATH by five factors: *fear of technological advances*, *declining cost*, *cost*, *perceived ease of use*, and *self-*

efficacy (or *requisite knowledge*). And, according to Brown and Venkatesh (2005), integrating MATH with a life cycle view (*marital status* (we included *sex* instead of *marital status*), *age*, and *presence/age of children*) that includes *income* (see Wagner & Hanna, 1983) allows to provide a richer explanation of household personal computer adoption (household mobile phone adoption in this study) than those provided by MATH alone. Finally, as shown in Figure 1, the dependant variable of the research model developed is related to *behavioral intention* (the intention to adopt (or buy) a mobile phone by people in household). All of the variables integrated in the theoretical research model depicted in Figure 1 are defined and the research hypotheses are developed in the full version of the paper.

Figure 1
Theoretical Research Model



METHODOLOGY

The study was designed to gather information concerning mobile phone adoption decisions in Atlantic Canadian households. The focus of the study is on individuals who do not yet own a mobile phone. We conducted a telephone survey research among individuals of a large area in Atlantic Canada. In this section, we describe the instrument development and validation, the sample and data collection, as well as the data analysis process.

Instrument Development and Validation

To conduct the study, we used the survey instrument developed and validated by Brown and Venkatesh (2005) to which we added two new scales measuring some other dimensions in intention to buy a mobile phone by people in household, that is, utility for security and mobility. The survey instrument was then translated in French (a large part of the population in Atlantic Canada is speaking French) and both the French and English versions were evaluated by peers. This review assessed face and content validity (see Straub, 1989). As a result, changes were made to reword items and, in some cases, to drop items that were possibly ambiguous, consistent with Moore and Benbasat's (1991) and DeVellis's (2003) recommendations for scale development. Subsequent to this, we distributed the instrument to a group of 25 MBA students for evaluation. Once again, minor wording changes were made. Finally, we performed some adjustments to the format and appearance of the survey instrument, as suggested by both peers and MBA students, though these minor changes had not a great importance here given the survey was administered using the telephone. As the instrument was already validated by Brown and Venkatesh (2005) and showed to be of a great reliability, and that we added only few items to measure two new variables, then we have not performed a pilot-test with a small sample. The evaluations by both peers and MBA students were giving us some confidence that we could proceed with a large-scale data collection.

Sample and Data Collection

First, in this study, we chose to survey people in household over 18 years taken from a large area in Atlantic Canada who do not yet own a mobile phone. To do that, undergraduate and graduate students studying at our faculty were hired to collect data using the telephone. A telephone was then installed in an office of the faculty, and students, one at a time over a 3 to 4-hour period, were asking people over the telephone to answer our survey. And in order to get a diversified sample (e.g., students, retired people, people not working, people working at home, and people working in enterprises), data were collected from 9 a.m. to 9 p.m. Monday through Friday over a 5-week period. Using the telephone directory of the large area in Atlantic Canada chosen for the study, students were randomly selecting people and asking them over the telephone to answer our survey. The sample in the present study is therefore a randomized sample, which is largely valued in the scientific world given the high level of generalization of the results got from such a sample. Once an individual had the necessary characteristics to answer the survey and was accepting to answer it, the student was there to guide him/her to rate each item of the survey on a seven points Likert-type scale (1: strongly disagree … 7: strongly agree). In addition, the respondent was asked to answer some demographic questions. Finally, to further increase the response rate of the study, each respondent completing the survey had the possibility to win one of the 30 Tim Hortons $10 gift certificates which were drawn at the end of the data collection. To that end, the phone number of each respondent was put in a box for the drawing. Following this process, 307 people in household answered our survey over a 5-week period.

Data Analysis Process

The data analysis of the study was performed using a structural equation modeling software, that is, Partial Least Squares (PLS-Graph 3.0). Using PLS, data have no need to follow a normal distribution and it can easily deal with small samples. In addition, PLS is appropriate when the objective is a causal predictive test instead of the test of a whole theory (Barclay et al., 1995; Chin, 1998) as it is the case in this study. To ensure the stability of the model developed to test the research hypotheses, we used the PLS bootstrap resampling procedure (the interested reader is referred to a more detailed exposition of bootstrapping (see Chin, 1998; Efron & Tibshirani, 1993)) with an iteration of 100 sub-sample extracted from the initial sample (307 Atlantic Canadian people). Some analyses were also performed using the Statistical Package for the Social Sciences software (SPSS 13.5). The results are presented and discussed in the full version of the paper.

CONCLUSION

To conclude, much more research will be needed on the adoption of technology in households in order to better understand its impacts on people's daily life. The research will allow, among others, at least to minimize, if not to remove, some negative impacts of technology in people's daily life in the future and to develop new technologies still better adapted to people's needs. We will continue to inquire into this new and exciting field.

ACKNOWLEDGMENTS

The authors would sincerely like to thank professor Wynne W. Chin (University of Houston at Texas) who kindly offered to us a license of the last version of his structural equation modeling software PLS to perform the data analysis of this study. We are also grateful to the *Faculté des Études Supérieures et de la Recherche* (FESR) at the University of Moncton for its financial contribution to this study.

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AN EXTENDED MODEL OF ADOPTION OF TECHNOLOGY IN HOUSEHOLDS: A MODEL TEST ON PEOPLE USING A MOBILE PHONE

Gérard Fillion, University of Moncton
Thang Le Dinh, University of Moncton
gerard.fillion@umoncton.ca

ABSTRACT

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INTRODUCTION

Since numerous years, mobile phone is used for different professional purposes, particularly by senior managers in the workplace. And this technology is more and more used in the workplace since mobile applications have been integrated to actual enterprise business strategies. Individual adoption of technology has been studied extensively in the workplace (Brown & Venkatesh, 2005). Far less attention has been paid to adoption of technology in the household (Brown & Venkatesh, 2005). Obviously, mobile phone is now integrated into our daily life. According to the more recent forecast of Gartner Research, 986 millions of mobile phones have been sold throughout the world in 2006 (Ouellet, 2006). And, as the tendency is showing up, mobile phone use will be continuously increasing in the future. The purpose of this study is then to investigate who uses a mobile phone, and why? In other words, we try to identify who really are the users of a mobile phone and what are the determining factors who make such that they are using a mobile phone?

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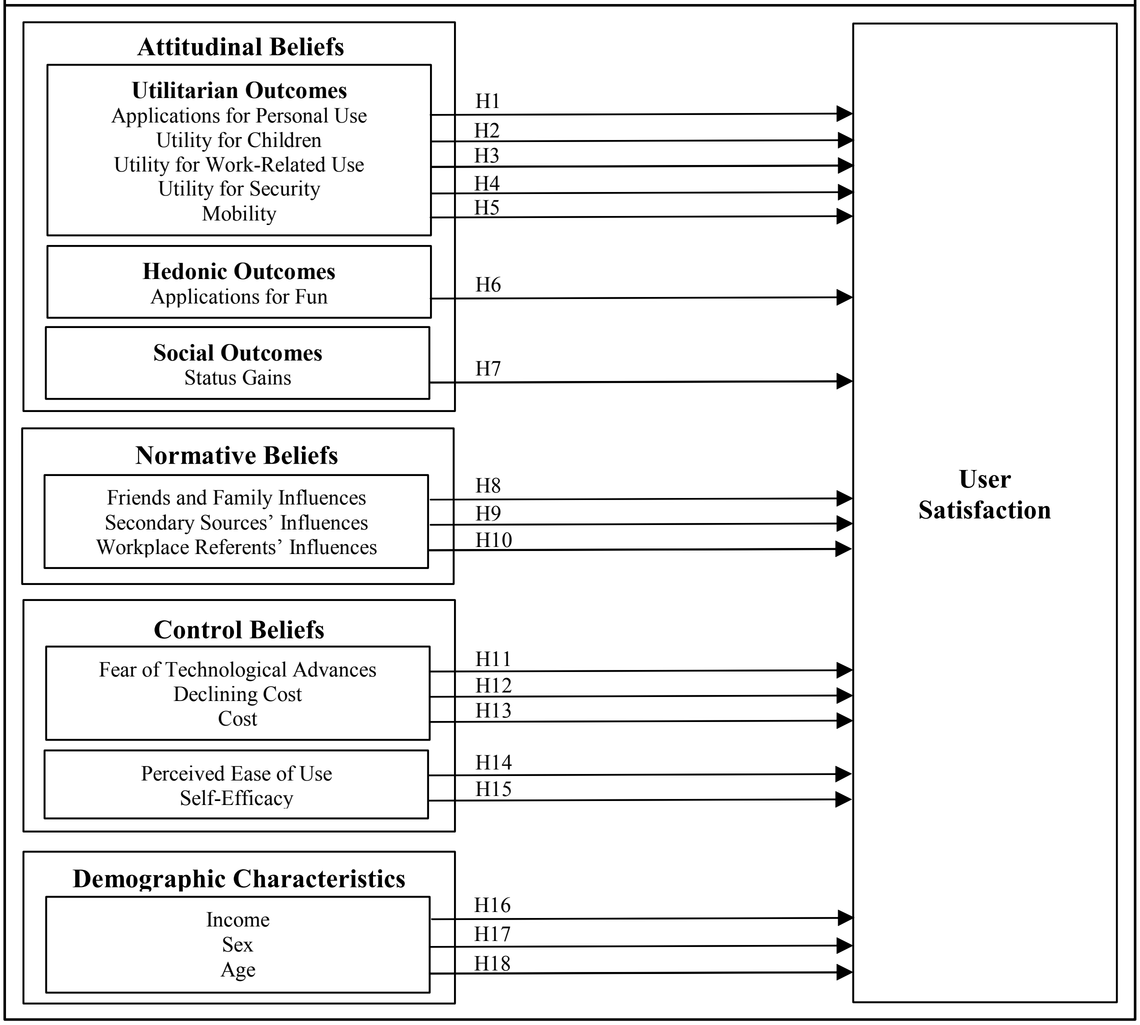

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To conduct the study, we used the survey instrument developed and validated by Brown and Venkatesh (2005) to which we added three new scales, the first two measuring other dimensions in satisfaction in the use of mobile phone by people in household, that is, utility for security and mobility, and the last one measuring user satisfaction as such. The survey instrument was then translated in French (a large part of the population in Atlantic Canada is speaking French) and both the French and English versions were evaluated by peers. This review assessed face and content validity (see Straub, 1989). As a result, changes were made to reword items and, in some cases, to drop items that were possibly ambiguous, consistent with Moore and Benbasat's (1991) as well as DeVellis's (2003) recommendations for scale development. Subsequent to this, we distributed the survey instrument to a group of 25 MBA students for evaluation. Once again, minor wording changes were made. Finally, we performed some adjustments to the format and appearance of the instrument, as suggested by both peers and MBA students, though these minor changes had not a great importance here given the survey was administered using the telephone. As the instrument was already validated by Brown and Venkatesh (2005) and showed to be of a great reliability, that we used the scale developed by Hobbs and Osburn (1989) and validated in their study as well as in several other studies to measure user satisfaction, and that we added only few items to measure the new variables utility for security and mobility, then we have not performed a pilot-test with a small sample. The evaluations by both peers and MBA students were giving us some confidence that we could proceed with a large-scale data collection. The specific measures are presented in Appendix A.

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A DESIGN OF COLLABORATIVE LEARNING ENVIRONMENT FOR NOVICES' CONCEPTUAL DATA MODELING

I-Lin Huang, Langston University
iHuang@lu-ns01.lunet.edu

ABSTRACT

The wide-spreading e-businesses and enterprise resource planning systems have been increasing the importance of the quality of database systems in current business environments. Conceptual data modeling has therefore become a critical concern because accurate data models are essential to building a well-functioning database. As a result, the demand for competent database designers has also grown dramatically.

However, conceptual data modeling is still an error prone process, especially for novice database designers. In order to improve the accuracy of data models, the entity-relationship modeling technique has long been accepted by academics and practitioners as an effective tool to help database designers to capture, understand, and represent business data requirements. However, the cognitive abilities of database designers are still the most important determinant for the accuracy of data models. Empirical studies have showed that the performance of novice database designers is significantly lower than that of expert database designers. In addition, empirical studies have also shown that (1) reasoning processes, and(2) knowledge organizations that support the reasoning processes account for the difference of cognitive abilities between novice and expert database designers.

This paper proposes a theoretical model of collaborative learning environment for conceptual data modeling on the basis of the findings from the research studies in novice-expert differences. The model explores three cognitive mechanisms for improving the success of novices in conceptual data modeling: (1) an example base as a tool for training novices in analogous thinking and solution planning, (2) a rule base as a tool for training novices in rule-based logical thinking, and (3) collaborative argumentation as the tool for training novices in critical thinking, team working, and interest and self-confidence building. By integrating solution planning, analogical thinking, logical thinking, critical thinking, and team working into novices' conceptual data modeling process, novices can learn a conceptual data modeling behavior similar to experts and consequently can have better performance in conceptual data modeling.

INTRODUCTION

Statistics show that database administration is one of five fastest growth areas in the job market for the first decade of the new millennium (Newsweek, 1999, page 44, New York Times, 2001). The growth of the demand for competent database designers reflects the importance of the quality of database systems in supporting wide-spreading e-businesses and enterprise resource planning systems in current business environments (Antony & Batra, 2002). The importance of the quality of database systems in current business environments has also been demonstrated by the vast expense of businesses in erroneous data due to poorly designed databases. According to an estimation, the erroneous customer data alone cost businesses on a global level ranging from under $100 billion to over $600 billion, not to mention the erroneous data in other aspects of businesses (Hillard, McClowry, & Na, 2007).

An accurate data model is essential to building a well-functioning database. In developing a database, the data model provides a blueprint and foundation for the structure of the database by showing an abstract representation of the data about entities, their associations and attributes within the intended business (Topi & Ramesh, 2002). If the data model is flawed, the quality of the resulting database will be compromised.

However, conceptual data modeling is an error prone process (Antony & Batra, 2002; Batra, 2005; Batra and Sein; 1994; Sutcliffe and Maiden, 1992), especially for novice database designers. In order to improve the accuracy of data models, the entity-relationship modeling technique has long been accepted by academics and practitioners as an effective tool to help database designers to capture, understand, and represent business data requirements (Antony & Batra, 2002; Batra and Davis, 1992; Batra and Sein; 1994). However, the cognitive abilities of database designers are still the most important determinant for the accuracy of data models. It has been reported that novice database designers literally follow the stated requirements to specify entity-relationship models (Batra & Antony, 1994). As a result, the relationships that are not expressed obviously in requirement statements become the main source of errors committed by novices. On the other hand, with better modeling knowledge expert database designers can use data modeling techniques to perform model-based reasoning more effectively. In addition, expert database designers can reuse rich and well-organized model patterns from their experience (Batra and Davis, 1992; Batra and Sein; 1994; Sutcliffe and Maiden, 1992). As a result, expert data designers show significantly better performance in data modeling than novice data designers

It is believed that there are two cognitive characteristics that account for the difference of cognitive abilities between novice and expert database designers: (1) reasoning processes, and (2) knowledge organizations that support the reasoning processes. In addition, the learning process is slow for novice database designers to reach the expert level of reasoning processes and knowledge organizations (Huang, and Burns, 2000; Schenk, Vitalari, and Davis, 1998). Therefore, the research question for this paper is how to help novice database designers achieve more accurate data models even with relatively inadequate reasoning processes and knowledge organizations.

This paper proposes a theoretical model of collaborative learning in conceptual data modeling on the basis of the findings from the research studies in novice-expert differences (Huang, 2006). The model explores three cognitive mechanisms for improving the success of novices in conceptual data modeling: (1) an example base as a tool for training novices in analogous thinking and solution planning, (2) a rule base as a tool for training novices in rule-based logical thinking, and (3) collaborative argumentation as the tool for training novices in critical thinking, team working, and interest and self-confidence building. By integrating solution planning, analogical thinking, logical thinking, critical thinking, and team working into novices' conceptual data modeling process, novices can learn a conceptual data modeling behavior similar to experts and consequently can have better performance in conceptual data modeling.

The rest of this article will be organized into two sections. First, a design of collaborative learning environment for novices' data modeling will be proposed. And then the conclusion will be made in the second section.

A DESIGN FOR COLLABORATIVE LEARNNG ENVIRONMENT

On the basis of research findings in novice-expert differences, this section will first discuss the functional goals that a learning environment needs to achieve in order to provide effective support for novices' conceptual modeling. Then a framework for collaborative learning environment for novices' conceptual data modeling will be proposed. In addition, how the collaborative environment achieves the functional goals is also discussed.

A. Functional Goals for an Effective Learning Environment

On the basis of the theories from cognitive research in novice-expert differences (Huang, 2006), three functional goals for effective learning environments for novices' conceptual data modeling are proposed as follows:

1. Promoting expert-like problem solving behavior.

Specifically, the learning environment will support the following three problem solving features: (1) Use top-down approach to solve problems. Experts arrange their knowledge around "problem schemata". By using analogical reasoning, experts reuse similar problem schemata to make top-down approach to solve problems possible. (2) Effectively retrieve relevant pieces of knowledge from a vast repertoire of domain knowledge. Experts conditionize their knowledge to include a specification of contexts in which it is useful. By this way, each piece of knowledge is like a "rule" that can be triggered by contextual information. As a result, experts can perform rule-based logical reasoning effectively. And (3) Plan the solution to the problem before start detailing the solution. The most important characteristic that differentiates experts from novices is that experts try to understand the problem situation as a whole before beginning to work on the solution. Novices jump right in.

2. Minimizing cognitive load

Cognitive load theory assumes that human problem solvers have a limited working memory connected to an unlimited long-term memory (Sweller, 1988). If an instruction design requires learners to engage in complex reasoning processes involving unfamiliar concepts, the learners may overload their working memory and consequently are unable to solve the problem. Therefore, minimizing cognitive load in instruction design is particularly important for support the learning of novices because their relatively weaker background on problem solving skills.

3. Increasing interest and self-confidence

For novices such as college students, it may be more important than others to increase interest and to build self-confidence in the process of data modeling. Some research studies showed that if students believe they cannot solve a problem, they are likely unable to do it. In addition, interest and self-confidence will provide motivation for active learning and a base for life-long learning.

B. The Framework for Collaborative Learning Environment for Conceptual Data Modeling

As shown in the figure 1 below, the proposed learning environment can be specified as Follows:

1. Problem Statement:

A problem Statement is a description about the data requirements that needs to be modeled as an entity-relationship model by the novice database designers. The problem statement is assigned by the instructor to the novices to solve it as a team.

2. Example Base and Example Display

- The problem-solution pairs are stored in example base and can be retrieved and displayed in example display. Each problem-solution pair acts like a problem schema that includes three components: a problem statement, a modeling procedure, and the resulting entity-relationship model.
- Example base and example display promote expert-like problem solving behavior in the following two aspects: facilitate analogical reasoning, and facilitate planning solution
- Example base and example display act as an external memory for problem schemata to reduce the students' cognitive load.

3. Conditionized Knowledge Base and Conditionized Knowledge Display

- The conditionized knowledge is stored in conditionized knowledge base and can be retrieved and displayed in conditioned knowledge display.
- Each piece of conditionized knowledge is implemented as a "rule" with three components: (i) the context that a principle can be applied, (ii) the principle, and (iii) an example that shows how to apply the principle.
- Conditionized knowledge base and conditioned knowledge display promote expert-like problem solving behavior by facilitating rule-based logical reasoning
- Cognitive load is reduced by conditionizing principles into rules
- Conditionized knowledge base and conditioned knowledge display act as an external memory for conditionized knowledge to reduce the novices' cognitive load.

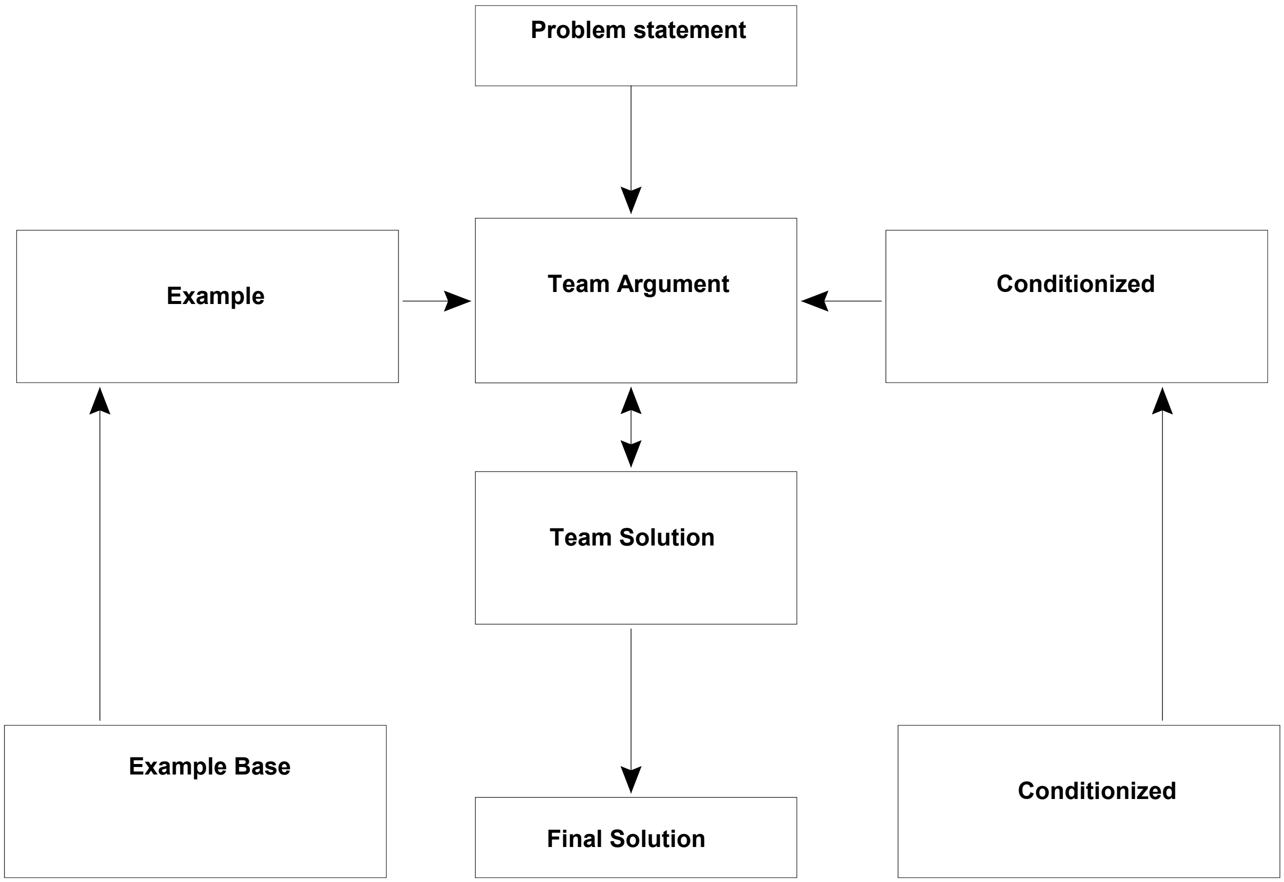

Figure 1: The Framework for Collaborative Learning Environment for Conceptual Data Modeling

4. Team Argument Working Area
- Team argument working area is an electronic chat room, a white board, or simply a piece of paper that provides an environment for novices to discuss and argue the concepts in the problem statement and possible modeling solutions.
- Team argument working area supports collaborative learning, minimizes cognitive load, and increases interest and self-confidence.

5. Team Solution Working Area
- Team solution working area can be an electronic whiteboard, a traditional white board, or simply a piece of paper.
- Team solution working area provides a space to show the solution in progress, support collaborative learning, minimizes cognitive load, and increases interest and self-confidence

6. Final Solution

Final solution is the solution for the assigned problem. It is shown in the team solution working area.

7. Online Education and Learning Management System

Currently, the collaborative learning environment for novices' conceptual data modeling is implemented manually. However, it could be more effective if being implemented in an on-line education and learning management system such as Web CT or Blackboard.

CONCLUSION

Traditionally, the research studies for improving the modeling performance of novice database designers have focused on providing access to domain and modeling knowledge through computer-aided software engineering (CASE) tools. However, this research is concerned with how to improve novices' cognitive abilities for conceptual data modeling. On the basis of the research findings from novice-expert differences in problem solving, this research has proposed a design of collaborative learning environment for novice conceptual data modeling. Guided by an example base, and a rule base, novice database designers are instructed to work together in a team format. By perform expert-like ways to specify entity-relationship models, novice database designers are expected to achieve more correct entity-relationship models. Currently, initially results from implementing the learning environment for a group of college students are encouraged. Moving the learning environment to an on-line education and learning management system is also under way.

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ACQUIRING DOMAIN KNOWLEDGE OF INFORMATION SYSTEMS: THE INFORMATION SYSTEM UPON INFORMATION SYSTEMS APPROACH

Thang Le Dinh, University of Moncton
thang.le.dinh@umoncton.ca
Gérard Fillion, University of Moncton
gerard.fillion@umoncton.ca

ABSTRACT

Nowadays, knowledge is viewed as a significant asset for organizations. Consequently, knowledge management has become an important factor to take into account within and between organizations. This paper proposes an approach for acquiring domain knowledge of information systems (IS) based on conceptual specifications. It is argued that the development process of information systems may include several development and maintenance projects, which could be carried out in parallel, and each project may use its own software process and development method. In order to support the different activities of the IS development process, it is suggested that the development process itself needs a knowledge architecture for managing its domain knowledge. To that end, we propose a knowledge architecture called Information System upon Information Systems (ISIS). An ISIS is considered as a new knowledge-based infrastructure which coexists with other IS infrastructures. It aims at managing the IS domain knowledge. Knowledge management involves activities such as acquiring, analyzing, preserving, and using knowledge. In the present paper, we suggest an approach for acquiring IS domain knowledge, including its identification and organization.

INTRODUCTION

Nowadays, knowledge is viewed as a significant asset for organizations. Consequently, knowledge management has become an important factor to take into account within and between organizations. Activities of knowledge management include acquisition, analysis, preservation, and application of knowledge. Knowledge management allows an organization to leverage its information resources and knowledge assets by remembering and applying experience (Jetter et al., 2006; Watson, 2003).

Domain knowledge is defined as the knowledge of the area to which a set of theoretical concepts is applied and is fundamental to all disciplines (Alexander, 1992). Concerning the information systems (IS) discipline, the term "IS domain knowledge" provides representations, methods, techniques, and tools that form the basis for the development of information systems (Khatri et al., 2006).

On the other hand, the IS development process is becoming more and more complex. It may include several development and maintenance projects that are at different stages of the life cycle.

Those projects may be carried out in parallel and in a distributed environment, and they may use different software processes, methods, and tools. This tendency offers numerous potential advantages, but also leads to certain challenges regarding the capacity to manage and coordinate effectively such environments.

In our research, we address the challenge of managing the IS development process using a knowledge architecture. We propose a typical information system, called *Information System upon Information Systems* (ISIS) that supports the knowledge architecture (Le Dinh, 2004). An ISIS can be viewed as a new knowledge-based infrastructure that coexists with other IS infrastructures. The ISIS will help an organization to handle its IS domain knowledge, including acquiring, analyzing, preserving, and using knowledge.

The paper focuses on acquiring IS domain knowledge. By acquiring domain knowledge, we mean to control knowledge by identifying and organizing it. The remaining of the paper is structured as follows: first, we present a brief literature review; second, we proceed to the identification of different categories of domain knowledge; third, we discuss the organization of this knowledge; and we end the paper with some conclusions and future directions.

LITERATURE REVIEW

Although several studies argue that domain knowledge has a great impact on IS problem-solving effectiveness (Blumm, 1989; Curtis et al., 1988; Glass & Vessey, 1992; Khatri et al., 2006), fewer studies will have investigated the role of *conceptual modeling*, an important subset of IS development, in domain knowledge management. Indeed, conceptual modeling has an important impact on system development costs, flexibility, and the ability to meet users' requirements (Moody, 1998; Witt & Simsion, 2004).

Prior studies in the area of conceptual modeling have focused on two aspects (Khatri et al., 2006): (a) *Development of a conceptual schema*: involves developing a schema based on users' requirements (Kim et al. 1995); and (b) *Understanding of a conceptual schema*: assumes existence of a schema and accesses schema understanding (Bodart et al., 2001).

Our research focuses on the latter: we consider that *conceptual specifications* can help IS professionals to access schema understanding. In fact, conceptual specifications of the business domains are tied to play an important role in the deliverables consumed or produced in the IS development process. Conceptual specifications and their implementations can be found in all types of documents, including requirement, design and implementation documents as well as the user manuals.

Therefore, we consider that conceptual specifications, which represent the semantic content of information at the conceptual level, are the key information resources used in the IS development process. Consequently, our approach considers conceptual specifications as essential IS domain knowledge. This domain knowledge could be employed to manage IS development process.

This paper focuses on how to acquire domain knowledge and aims at answering the following questions: (a) What concepts should be considered part of domain knowledge? (b) How those concepts are interrelated? and (c) Why those concepts are valid? All these questions will be discussed in the next sections.

IDENTIFICATION OF DOMAIN KNOWLEDGE

This section addresses the challenge of identifying different categories of domain knowledge. As a matter of fact, several studies have sought to show IS professionals how to identify and model their systems (Wand et al., 2002) using different categories of knowledge: things, objects, entities, and properties/attributes (e.g., Wand et al., 1993); classes and class structures (e.g., Parsons, 1996); events, processes, and workflows (e.g. Basu et al., 2000; Curtis et al., 1992); and decompositions and level structures (e.g., Paulson et al., 1992).

However, according to us, there is a little attention to examine all the categories of IS domain knowledge in a coherent manner in order to answer the questions of *What*, *How*, and *Why* in the previous section.

For this reason, our paper aims at presenting the different categories of IS domain knowledge in a global and coherent manner. First, IS domain knowledge will be classified and studied according to the three aspects of information systems: the Static, the Dynamic, and the Integrity rules aspects. Second, key concepts of each aspect of IS will be presented; each concept is corresponding to a category of IS domain knowledge. Third, the relation between concepts within and between aspects of IS will be also discussed.

The development of an information system is actually related to modeling, specifying, and realizing the concepts from the business domain, which are called *Informational concepts*. Informational concepts may represent: *Structure of information* (e.g, "Invoice" concept); or *Transformation of information* (e.g., "Paying an invoice" concept); or *Coherence of information* (e.g., a business rule concept that states: "the total amount of all the payments of an invoice must not exceed the amount of that invoice"). In other words, an informational concept from the business domain may be represented by an IS concept from the IS domain. An IS concept could belong to the *Static aspect* (structure of information), the *Dynamic aspect* (transformation of information), or the *Integrity rules aspect* (coherence of information) of an IS.

Despite the diversity in IS development methods and methodologies, there are some IS concepts that are invariant (for example, the "class" concept). Those concepts are called IS *key concepts*. Each IS concept may correspond to a certain type of conceptual specifications. In the following, we present the IS *key concepts* corresponding to the Static, Dynamic, and Integrity rules aspects.

Concepts of the Static Aspect

The concepts of the Static aspect describe what types of information exist, their structures, as well as their interrelations. They include *Atomic-class*, *Tuple-class*, *Hyperclass*, *Attributes*, *Key*, and *Subclass*.

An object type and a set of objects of this type define a class. In our approach, there are three kinds of classes: An *atomic-class*, which is defined as a primitive class and indecomposable. Objects of an atomic-class have a particular characteristic: their identifier is also their value. A *tuple-class*, which contains objects having the same structure and the same behavior. A structure of a tuple-class is characterized by a set of attributes. The behavior of a tuple-class is represented by a set of methods. And a *hyperclass*, which is a subset of classes that are all connected without ambiguity by navigation links to a root class (Andany et al., 1991; Turki, 2002).

The interrelations between the above concepts lead to other concepts such as *Attribute, Key,* and *Subclass*. An *attribute* of a class is a function corresponding to every object of this class and to a set of objects of other classes. A *key* of a class is defined by a set of special attributes which can be used to distinguish one object from other objects in the same class. A class can define its *subclasses*. The interpretation of a subclass is the set of all identifiers of the interpretation of its superclass for which the specialization condition is evaluated to "true".

Concepts of the Dynamic Aspect

The concepts of the Dynamic aspect are present in the two levels of behavior: (a) Local behavior is defined as the behavior of objects of a class, including the concepts of *Dynamic states* and *Method*; and (b) Global behavior is defined as the behavior of the whole IS, including the concepts of *Event* and *Process*.

The local behavior is represented by the concepts of *Dynamic State* and *Method. Dynamic states* of an object are modes or situations during which certain methods are "enabled" and other methods are "disabled". A *method* of a class is used to transit between the dynamic states of the objects of this class. In other words, a method transfers a set of dynamic states to another set of dynamic states of a class.

The global behavior is represented by the concepts of *Event* and *Process*. *Event* is a remarkable phenomenon outside of the IS that may provoke a change of its dynamic states. In fact, the event structure helps to define the interface of the IS with its environments. A *Process* is a feedback of the IS to the occurrence of an event. In fact, a process performs a transformation of a set of dynamic states of the IS.

Concepts of the Integrity Rules Aspect

The Integrity rules aspect includes the concepts of its main components such as *Integrity Rule* and *Primitive*, as well as about their interrelations such as *Scope* and *Risk* (Léonard, 2003; Luu & Léonard, 2002).

Integrity rules (IR) represent the business rules of an organization. An IR is actually a logical condition defined over a subset of tuple-classes that can be formally specified and verified by processes or methods. A *Primitive* is a basic operation on a tuple-class such as *create*, *update*, and *delete*. The execution of a primitive may violate the validation of an IR. *Scopes* of an IR represent the context of an IR, including a set of tuple-classes on which the IR has been defined. *Risks* are the possibilities of suffering the incoherence of information. In general, a risk is defined on a scope and a primitive. In particular, especially in the case of the *update* primitive, it is indispensable to specify the related attribute of a risk.

ORGANIZATION OF DOMAIN KNOWLEDGE

Once knowledge is acquired, the next step is to apply experience or to apply domain knowledge based on the context of application. This section is then related to explain how to work with a semantic context, particularly a unique and coherent set of IS concepts.

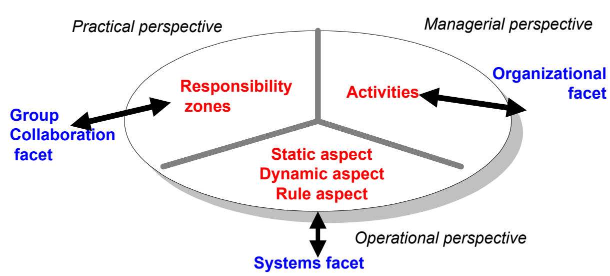
In other words, our approach must allow to work with a part of an IS, in particular a set of conceptual specifications as a semantic unit. We propose the concept of *IS component* that can be used to represent a semantic unit. Each IS component has a particular purpose. Since even the smallest organization has multiple purposes with different areas of concerns, it will potentially have many different IS components.

The concept of IS component allows to work with a part of an IS (Le Dinh & Léonard, 2002; Léonard et al., 2001) as a component. An *IS component* is a reusable artifact of an IS part that represents adequate characteristics of an autonomous system (Le Dinh & Léonard, 2002).

From the external view, an IS component can be considered as an autonomous IS that can be developed and delivered independently from the others. However, autonomy does not mean isolation. An IS component can be easily cooperating with other IS components to provide more valuable functionalities. From the internal view, an IS component is composed of a set of elements corresponding to the three facets of an IS and their transformations at different levels of abstraction.

Figure 1 provides an overview of the different elements of an IS component in accordance with the three facets of an IS. There are three standpoints for viewing the work within an organization: the *Operational perspective* as executions of operations on a system; the *Practical perspective* as events in the history of group practice; or the *Managerial perspective* as performances intended to fulfill organizational objectives in accordance with organizational rules (De Michelis et al., 1998). In our approach, the Practical perspective, which is reflected by the Group Collaboration facet, contains the *Responsibility zone* element. The Managerial perspective, which is reflected by the Organizational facet, contains the *Business activities* element. And the Operational perspective, which is reflected by the System facet, contains the elements of the *Static*, *Dynamic*, and *Integrity rules aspects* of an IS.

Figure 1. Overview of an IS Component



To represent the interactions of an IS component with the organizational environment, we define the concepts of *Activities* and *Responsibility zones*. *Activities* represent the organizational standpoint of a business process, whereas the corresponding processes of an IS component represent the computerized part of this process. A *Responsibility zone* (RZ) is a part of an organization-working environment.

CONCLUSION

In our research, we have shown the importance of a new knowledge architecture based on the *Information System upon Information Systems* (ISIS), which supports the management of domain knowledge used in IS development. Knowledge management involves the acquisition, analysis, preservation, and application of domain knowledge. We also consider that conceptual specifications, which represent the semantic content of information at the conceptual level, are the essential IS domain knowledge.

The contribution of this paper is to provide a unique and coherent framework for acquiring IS domain knowledge, including the identification and organization of knowledge based on the IS key concepts. The concepts proposed can be classified according to the three aspects of an IS such as: (a) The Static aspect: *Atomic-class*, *Tuple-class*, *Hyperclass*, *Attributes*, *Key*, and *Subclass*; (b) The Dynamic aspect: *Dynamic states, Method, Event*, and *Process*; and (c) The Integrity rules aspect: *Integrity Rule, Primitive, Scope*, and *Risk.* Concerning the Group Collaboration facet, there are the concepts of *Information system component*, *Responsibility zone,* and *Activities.*

The perspective of this work is to provide an effective knowledge-based architecture that would be best suited for the management and coordination of IS development and maintenance projects in a complex and distributed environment. We are actually working on analyzing, preserving, and using domain knowledge.

In order to experiment our approach, we are also to develop a first prototype of the ISIS in the Software-as-a-Service environment. The purpose of this prototype is to support IS domain knowledge management based on conceptual specifications. The prototype will allow working on some quality factors of conceptual specifications such as completeness, correctness, and integrity (Moody et al., 1998).

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References are available upon request.

REFINING UNDERLYING DEMAND FUNCTIONS USING INFORMATION FROM RELATED TIME SERIES

Glenn Maples, University of Louisiana at Lafayette
Ronald Heady, University of Louisiana at Lafayette
Zhiwei Zhu, University of Louisiana at Lafayette
glennmaples@louisiana.edu

ABSTRACT

This research focused on improving estimations of demand functions using information from a large number of related many-period time series. The key premise is that by improving the data's internal consistency random variation will be reduced in the component time series.

The research starts with the assumption that some of the demand time series are significantly correlated, some only slightly correlated, and some completely uncorrelated. To explain how these correlations may arise, a framework examines underlying causes and demonstrates that these root sources of correlations are pervasive in many manufacturing environments.

A process is then developed for improving the demand function of any distinct part by using the correlated demands of the other parts. Metrics of effectiveness are proposed and used to test the methodology. The resulting tests demonstrate the effectiveness of the method, referred to as an internally consistent correlations (ICC) method.

Importantly, the research makes no use of a clustering algorithm and no assumption about the "end use" of the data set. Thus, it is expected that the results will apply to a wide array of domains, including forecasting, data mining, signal processing, and process monitoring.

Key Words: Preprocessing Time Series Data, Reducing Time series Noise, Inventory Control, Demand Forecasting, Data Mining, Internally Consistent Correlations

USER INTERFACE COMPONENTS LAYOUT PROBLEM WITH A MULTI–CRITERIA APPROACH

S. K. Peer, K.S.R.M. College of Engineering
skp_ksrm@yahoo.co.in
Dinesh K. Sharma, University of Maryland Eastern Shore
dksharma@umes.edu

ABSTRACT

Some studies have shown that the techniques and tools of facilities layout problems can equally be applied for the layout design of user interface components in human–computer interface. The facilities layout problem varies from the location and layout of facilities in manufacturing plant to the location and layout of textual and graphical user interface components in the human–computer interface. In this paper, we propose an alternate approach to an existing approach that handles the sum of distance-weighted closeness relationships and distance-weighted interactions assigned relative weights in the objective function. The results of the proposed approach are compared with that of an existing approach.

1. INTRODUCTION

The multi-criteria objectives are classified as conflicting objectives and congruent objectives. Conflicting objectives aim at minimization of total flow cost and maximization of total closeness rating, whereas congruent objectives aim at minimization of distance weighted cost of several attributes, such as, flow, closeness rating, hazardous movements, etc. (Khare et al., 1988). Rosenblatt (1978), Dutta and Sahu (1981, 1985) presented an improvement procedure for facilities layout problem associated with two conflicting objectives. Sayin (1981) presented the layout procedures, considering the cost of distance weighted attributes of flow and closeness rating. Rosenblatt (1979), and Dutta and Sahu (1982) presented the quadratic assignment models associated with two conflicting objectives, where as Fortenberry and Cox (1985), Urban (1987, 1989), and Khare et al. (1988) presented the quadratic assignment models associated with congruent objectives. The models in prior research are similar in nature, and vary only in stating the relationship between the qualitative and quantitative measures in the cost term. In all these approaches the qualitative and quantitative factors (or goals) are not represented on the same scale.

The objective of this paper is to propose an alternate mathematical approach to an existing (Khare et al., 1988) approach. The existing approach presents a multi-goal facilities layout problem, considering the sum of distance-weighted congruent objectives of closeness relationships and the interactions assigned with relative weights. The proposed approach considers the distance-weighted sum of congruent objectives of normalized weighted closeness relationships and normalized weighted interactions in the objective function. Then, a two-step procedure, which includes the construction and improvement procedures, is used to obtain the layouts for the example task under consideration. The layouts obtained in the existing approach are evaluated with respect to the attributes of the objective function criteria values in the proposed approach. The results of both the approaches are compared on the same scale for the example task under consideration.

2. PROPOSED METHODOLOGY

This section presents a model for the multi–goal facilities layout problem with congruent objectives, handling the distance-weighted sum of normalized weighted closeness relationships and normalized weighted workflows in the objective function. Then the layouts are obtained, using the construction and improvement procedures of a two-step procedure. The layouts of an existing and the proposed approaches are compared, based on the attribute values of composite relationships of the proposed approach.

2.1. Model Formulation

The existing quadratic assignment model for multi–goal facilities layout problem, handling the sum of the distance-weighted attributes of closeness relationships and attributes of workflows assigned with relative weights in the objective function (Khare et al., 1988). In the existing approach, the qualitative and quantitative factors (or goals) may not be represented on the same scale. That is, the range of qualitative closeness relationships rating values may be different from that of quantitative interactions (or work flows) between the facilities. As a result, one of the factors (or goals) may be dominated by other factor (or goal) and have little impact on the final layout (Harmonosky and Tothero, 1992). We propose a model for the multi-goal facilities layout problem such that the final layout reflects the relative importance of the qualitative factor as well as the quantitative factor.

The methodology of the proposed approach begins with normalizing both the qualitative and quantitative factors individually. To normalize a qualitative factor, each relationship value is divided by the sum of all relationship values as given in equation (1).

$$R_{ik} = r_{ik} / \sum_{i}^{n} \sum_{k}^{n} r_{ik} \tag{1}$$

Where, r_{ik} = closeness relationship value between facilities i and k

R_{ik} = normalized closeness relationship value between facilities i and k

To normalize a quantitative factor, each quantitative workflow (or interactions) value is divided by the sum of all workflow (or interactions) values as given in equation (2).

$$F_{ik} = f_{ik} / \sum_{i}^{n} \sum_{k}^{n} f_{ik} \tag{2}$$

Where, f_{ik} = workflow (or interactions) value between facilities i and k

F_{ik} = normalized workflow (or interactions) value between facilities i and k

Then, the sum of distance-weighted normalized qualitative factor (or goal) and distance-weighted normalized quantitative factor (or goal) assigned with relative weights based on their importance are handled to obtain the cost term (A_{ijkl}) as given in equation (3).

$$A_{ijkl} = (W_1 R_{ik} d_{jl} + W_2 F_{ik} d_{jl}) \quad (3)$$

Where, $W_1 + W_2 = 1$, W_1 , $W_2 \geq 0$,
The resulting quadratic assignment problem is formulated as given in equation (4) to (5).

Minimize $$Z = \sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{n}\sum_{l=1}^{n}(W_1 R_{ik} d_{jl} + W_2 F_{ik} d_{jl}) X_{ij} X_{kl} \quad (4)$$

Subject to: $$\sum_{i=1}^{n} X_{ij} = 1, \quad j = 1, 2, \ldots, n \quad (5)$$

$$\sum_{j=1}^{n} X_{ij} = 1, \quad i = 1, 2, \ldots, n \quad (6)$$

$$X_{ij} = 0 \text{ or } 1, \forall\ i, j \quad (7)$$

where, $$X_{ij} = \begin{cases} 1, & \text{if facility } i \text{ is assigned to location } j \\ 0, & \text{otherwise} \end{cases}$$

The application of construction and improvement heuristics to the QAP has been the subject of many studies (Dutta and Sahu,1982; Harmonosky and Tothero, 1992). The results suggest that construction and improvement heuristics are effective and efficient in solving the Quadratic Assignment problems (QAP). Hence, a two-step procedure, involving construction and improvement procedures are used to obtain better layouts.

2.1 Construction Procedure

On the basis of normalized closeness relationship value, select the pair of facilities, with the highest normalized closeness relationship value in the list to place in the locations close together and the cost (score) is computed. Next, select the facility from the list with highest normalized closeness relationship value with one, but not both facilities in the layout, to place near to the location of facility in the layout and the resulting cost (score) is obtained. Another facility is, now to be selected (using previous criterion) having highest priority of getting placement along with already assigned facilities. The process is continued till all the facilities are assigned to available locations and the total cost (score) is computed. If there exists a tie between facilities for its selection to place in the plan area, tie is broken randomly with biasness. The constraints with respect to locations available for placement of assigned facilities and breaking of ties, there may be a number of alternative solutions for each solution.

2.2 Improvement Procedure

The layout generated using the construction procedure is taken as an initial layout for the improvement procedure. A pair-wise exchange process is followed to determine the best exchange of facilities at their locations. The exchanged layout will now become the initial layout. The pair-wise exchange process is followed after each new solution till there is no better solution possible. The better solution means that the value of the objective function is better than the previous solution.

4. APPLICATION

In this section, we will apply the proposed approach to the problem of the layout design of the facilities in a manufacturing plant as it relates to the optimum layout of the widgets in human-computer interface. In the problem of widgets layout for the interface design, the facilities can be a text or graphical user interface components (icons). The issues related to the cognitive and perceptual actions are considered as the qualitative factors, whereas the issues related to motor actions in moving and pointing a mouse are characterized as quantitative factors. Little research has been done in the layout design of user interface components (Shneiderman, 2000). Estimates of the perceptual and cognitive complexity plus the motor actions can be obtained for the task under consideration (Sears, 1992). In order to explain the application of the multi-factor facilities layout methodologies for the layout design of user interface components, an example task involved with a text and graphical user interface components is considered.

4.1 Example Task

In order to apply the proposed methodology for the layout design of the textual and graphical user interface components, a text edited in MS-WORD in John and Kieras (1996) is considered as an example task. The facilities layout models are used for the layout design of the textual and graphical user interface components (menus/icons). Hence, the example task is not included with the operations to type the missing characters. The text is considered as component 1 and it is required to be modified by deleting the strike-off characters, bringing the rounded phrase to the location indicated by an arrow, setting the text to have right justification, and spell checking as shown in the Fig. 1 of the example task. In order to accomplish these tasks, the user interface components to be used are Del, Cut, Paste, Right and Spell check, which are numbered as components 2, 3, 4, 5 and 6 respectively. The delete operation is performed by selecting the Cut operator from the generated with right-click of the mouse. The rating system used for the qualitative relationships between the pairs of components is: A=5, E=4, I=3, O=2, U=1 and X=0. The quantitative factor is characterized as the interactions between the various pairs of components. The interaction between the pair of components is defined as the use of one component immediately after another component to perform an operation. The interactions are observed to be ranging from 1 to 4 for the task under consideration.

In order to understand GOMS models that have arisen in the last decade and the relationships between them, an analyst must understand ~~each~~ of the components of the model (goals, operators, methods, and selection rules), the concept of level of detail, and the different computational forms that GOMS models take. In this section, we will define each of these concepts; in subsequent sections we will categorize existing GOMS models according to these concepts.

Fig. 1: The example task: editing a marked-up manuscript.

The closeness relationships between the components i and k, considering 3 qualitative factors (viz., familiarity, anxiety, and fear) aggregated into one qualitative factor, and the interactions between components i and k, considering 3 quantitative factors (viz., frequency-of-use, pace-of-interaction, and interaction style) aggregated into one quantitative factor for an intermittent user evaluated in the computer laboratory for a 6-component problem, and the distances between the locations j and l.

4.2 Computational Results

The problem was executed using the software package developed in 'C' programming language. The layouts and scores obtained using construction and improvement procedures of the existing approach and the proposed approach are compared with respect to the attributes of the proposed approach for different combinations of weights as given in Table 1.

Table 1: Evaluations of Layouts of Approach with Respect to Attribute Values of Approach

Weights	Construction Heuristic				% Improvement over Existing Approach	Improvement Heuristic				% Improvement over Existing Approach
W1 W2	Existing Approach		Proposed Approach			Existing Approach		Proposed Approach		
	Layout	Score	Layout	Score		Layout	Score	Layout	Score	
0 1	6 4 1 2 3 5	2.476	4 3 1 6 2 5	2.276	2.276	4 6 2 3 4 5	2.46	3 2 1 4 5 6	2.186	11.14
0.2 0.8	1 3 6 2 4 5	2.668	6 1 3 5 4 2	2.382	10.72	1 3 4 6 2 5	2.509	3 5 6 1 2 4	2.130	15.11
0.4 0.6	2 5 4 6 3 1	2.41	5 1 2 6 3 4	2.321	3.69	4 2 1 6 5 3	2.349	3 5 1 4 2 6	2.11	5.87
0.5 0.5	6 2 4 6 3 5	2.476	5 6 4 2 3 1	2.417	2.38	4 5 2 6 1 3	2.367	3 4 2 6 5 1	2.282	3.59
0.6 0.4	4 2 3 1 6 5	2.828	4 3 5 6 1 2	2.306	15.66	2 5 1 6 3 4	2.385	2 5 6 1 4 3	2.256	5.38
0.8 0.2	6 1 4 2 5 3	2.369	6 3 4 5 1 2	2.237	5.57	2 4 1 3 6 5	2.334	1 4 2 3 5 6	2.163	7.30
1 0	1 3 4 2 6 5	2.432	3 5 6 1 2 4	2.27	6.67	6 1 4 2 5 3	2.321	5 4 2 3 6 1	2.13	8.23
			Avg % Improvement		7.540			Avg.% improvement		8.09

Note: Due to the space limitations, other figures and data tables will be reported upon presentation of the paper.

5. CONCLUSION

In this paper, we have presented an alternate approach to the Khare et al. (1988) approach. The proposed approach presents an alternate quadratic assignment model in which the distances between the locations weigh the sum of a weighted normalized qualitative factor and a weighted normalized quantitative factor in the objective function, so that the final layout reflects the relative importance of each factor. It is observed from the results of the proposed approach that the solution is improved using the improvement procedure over the construction procedure.

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(A complete list of references is available upon request from Dinesh Sharma at dksharma@umes.edu)

THE INFLUENCE OF DECISION COMMITMENT AND DECISION GUIDANCE ON DIRECTING DECISION AID RECOMMENDATIONS

Darryl J. Woolley, University of Idaho
dwoolley@uidaho.edu

ABSTRACT

This study considers factors that influence whether decision-aid users direct decision aid recommendations toward their prior beliefs. Desiring to confirm their beliefs, decision aid users may seek to direct decision aid recommendations toward their prior opinions. Cognitive dissonance theory suggests that this is more likely to occur when users are strongly committed to their opinions. However, if decision-makers receive guidance from a decision aid, they may be less likely to direct decision aid recommendations toward their prior belief. In the first of two experiments, professional auditors were more likely to direct decision aid recommendations if they were committed to a decision before using the aid. In the second experiment, graduate business students were more likely to accept a decision aid's initial recommendation when the decision aid provided guidance. However, the decision aid guidance did not stop users from directing the decision aid recommendation toward their prior belief; rather, it appeared to influence users who otherwise would have shifted away from both the decision aid recommendation and their own prior belief. This study contributes to research on decision aid use by finding that both professional and non-professional decision aid users direct decision aid recommendations toward their prior belief, and that they are influenced by the degree of their decision commitment and the guidance they receive from the decision aid.

Keywords: Decision support

USING GST TO ANALYZE THE COLLAPSE OF AOL

Nicholas John Robak, Saint Joseph's University
nickrobak@rcn.com

ABSTRACT

In 1972 Fremont E. Kast and James E. Rosenzweig published "General Systems Theory: Applications for Organization and Management " in the Academy of Management Journal*. Over the more than thirty years since publication this article has become a classic. The writing is quite theoretical and abstract. This paper will take the highly conceptual, often abstruse, terminology used in the article and take the current status of AOL (America Online) to illustrate the mechanics articulated and thereby illustrate the applicability and relevance of the article today.*

INTRODUCTION

en·tro·py (µn"tr…-p¶) *n. pl.* **en·tro·pies 1.** *Symbol* **S** For a closed thermodynamic system, a quantitative measure of the amount of thermal energy not available to do work. **2.** A measure of the disorder or randomness in a closed system. **3.** A measure of the loss of information in a transmitted message. **4.** A hypothetical tendency for all matter and energy in the universe to evolve toward a state of inert uniformity. **5.** Inevitable and steady deterioration of a system or society. [German *Entropie* Greek *en-* in; See **en-** ²Greek *trop*¶ transformation; See **trep-** in Indo-European Roots.] (1992)

The crisis that exists in AOL is well documented (Bosavage, 2006). America Online emerged from an amalgam of early PC communication attempts, online gaming companies, and communications services which were founded, expanded, transformed and finally consolidated after six years of trial and error (1983-1989). Although "America Online" was initially a conglomerate of several separate online services the company became one in 1991 using a graphic interface over the DOS operating system.

In 1991 it had about 150,000 users and ranked a distant third to CompuServe and Prodigy (Swisher, 1998, p.59-60). AOL went public in 1992 on NASDAQ offering 2 million shares at $11.50 each (Swisher, p.62). >From that point on the growth of the company was phenomenal. In 1993 it had 500,000 members, in 1994, one million members, by 1995 it had 4.5 million, by 1996, 7 million, and it hit 10 million members in the United States with one million additional abroad in 1997.

In 1997 AIM (America Online Instant Messenger) debuted. The AIM feature was enormously popular. This exponential growth continued. In 1998 AOL acquired CompuServe and Netscape and had 15 million subscribers. In 1999 it developed a partnership with Sun Microsystems and in 2001 AOL merged with Time Warner and was worth $200 billion (Bosavage, 2006). AOL peaked in members with 34 million in 2002. By the 2Q of 2006 AOL had fewer than 17.7 million subscribers, is losing nearly 1 million a Quarter, and is worth only $20 billion. (At last estimate, March 2007, there were 12 million U.S. subscribers.) (AP News) How can such a meteoric rise be so quickly reversed?

GENERAL SYSTEMS THEORY

Although Fremont E. Kast and James E. Rosenzweig wrote their seminal article "General Systems Theory: Applications for Organization and Management," (Kast & Rosenzweig, 1972) more than thirty years ago, it remains a staple for Information Systems' Theorists in their study of "Analysis and Design." Kast and Rosenzweig give a masterful historical and theoretical presentation in a little more than ten short pages of text.

It is the concept of "entropy," which becomes the fundamental *tour de force*, enabling the authors to vivify the concept of system and its infra as well as supra interactions. Although "cybernetics" is mentioned explicitly only once in regard to the concept of "feedback," its impact is latent throughout this paper. If "cybernetics" is indeed based on "Negative feedback" as is stated in the article (Kast & Rosenzweig, p. 16) and gets its etymology from the Greek *kybernetes* (steersman, governor, pilot, or rudder), one has to question where AOL went wrong and why it has maintained the wrong direction into near obsolescence.

In the General Systems Theory (GST) article the authors argue that "... questions of organizational effectiveness must be concerned with at least three levels of analysis. The level of the environment, the level of the social organization as a system, and the level of the subsystems (human participants) within the organization" (Kast & Rosenzweig, p. 20). They go on to state "Perhaps much of our confusion and ambiguity concerning organizational effectiveness stems from our failure to clearly delineate the level of our analysis and even more important, our failure really to understand the relationships among these levels" (Kast & Rosenzweig, 20).

Nowhere are these "levels" and their "relationships" better articulated than in the works of Talcott Parsons. In an earlier paper the author uses Parsons to explain a "simple" technological change in the adoption on the mouse and pointing devices in modern computing (Robak, 2001). It is appropriate to now expand this "Parsonian Perspective" to articulate the actions on "entropy" in the analysis of corporate demise.

Parsons uses four levels of action separate yet interrelated. They are Cultural, Societal, Personality, and Organismic. Parsons explains the relations among the subsystems through the term "cybernetic hierarchy of control" (Turner & Maryanski, p. 80). "The systems vary in the amount of "informational control" and "energy" and each level is necessary for control and regulation as well as provision of energy for the next" (Robak, p. 37). The direction is opposite from that taken in the previous paper since "control of the mouse," would emanate from the Organismic because the eye-hand coordination necessary for proper mouse movement is within this realm. In fact, the last two levels (Personality and Behavioral Organism) are realms within the actor; one concerning mental activity, the other physical, and these last two can be bifurcated in the mouse example. However, in the AOL example, the analysis is at the Macro level and the separation is unnecessary.

FUNCTIONAL REQUISITES

Control of the overall Macro System comes from the Cultural System and works its way to the Social System then to the Personality System. The "Functional requisites" are Adaptation; Integration; Goal Attainment; and Latency (also known as pattern maintenance). Turner and Maryanski (1979) provide a concise yet thorough description:

Adaptation	All action systems must seek resources from the environment, convert them into usable facilities, and then distribute them to the rest on the system.
Integration	All action systems must maintain coherent interrelationships among their constituent parts, and inhibit tendencies for abnormalities in the relations among the parts.
Goal Attainment	All action systems must set goals, establish priorities and allocate resources in order to achieve them.
Latency	All action systems must (a) generate use units that can fit into the system (the problem of "pattern maintenance"), and (b) reduce tensions within units of the system ("tension management"). (p. 75).

"Each of these in turn, rests primarily within a given action system but there are interchanges which allow for the viability of all of the subsystems. The primary adaptive subsystem is the Organismic, the Personality deals with goal attainment, the Social System meets integrative problems, and the Cultural will deal with latency. It is important to remember that the interchanges among these subsystems are what allow for total system efficacy." (Robak, p.38).

Given these overall parameters, how did entropy prevail so as to bring a company with such tremendous momentum to a halt? An additional factor to consider is that of "Cultural Lag," as is articulated by William Fielding Ogburn (Ogburn, 1922). Culture consists not only of social institutions and social ways, but also of the material objects existing and being generated by that society. Objects of technical relevance serve to exacerbate this phenomenon. Rarely was this truer than with the introduction of the Internet and the World Wide Web. Artifacts such as Internet Service Providers (ISPs) and web browsers were introduced, then used, then taken for granted, in a very short period of time. People and companies that could properly capitalize on their usage would quickly gain a competitive edge.

CompuServe Information Service was first introduced in 1979 by an Ohio-based organization and it initially served investors allowing them to access stock quotes (current and historic) at a moment's notice. It was acquired by H&R block in1980 and added features such as Electronic Mail, Online Shopping, and airline schedules and reservations. Its growth was slow but stable and peaked at 3 million users in 1995.

Prodigy, a brainchild of IBM and Sears, Roebuck and Company in 1987, actually had the internet lead in 1993 with more than 40% of the online market, while at that time, America Online located in Vienna, Virginia was just really beginning with fewer than 500, 000 subscribers. Its phenomenal growth is described at the beginning of this paper and peaked in 2002 with 34 million members and along with its Time Warner merger was thought to be worth $200 billion. Along the way it had acquired CompuServe (1998), Netscape, Global Network Navigator (1995), formed a partnership with Sun (for the purpose of Netscape sharing), and popularized Instant Messenger. Most of the early growth was under Steve Case who joined AOL in 1983 and rose to CEO in 1991 and Chairman in 1995, he resigned as Chairman in 2003.

AOL attracted most of its users when the primary mode of connection was "dial-up." It had a restrictive ("walled garden"), yet attractive approach to the Internet. The AOL approach was deemed to be "less technical" and therefore "easier" for those who were new to the internet; it also had "parental controls" which appealed to those adults who had children who would be using the internet. After the introduction of "instant messaging" those children would be hooked, being able to interact with their friends at all hours. As one can see the early features of AOL fit the emerging internet culture quite well and indeed, this was the biggest reason for rapid adoption in the early years, as it quickly swept past CompuServe and Prodigy on its way to domination at the beginning of the new millennium. Despite some initial difficulty with inability to connect all of the users in this growth phase (in the early years of overuse and under capacity AOL was often referred to as "America On Hold!"), AOL persevered and its initial momentum carried it through.

At the beginning of its growth phase, it carpet bombed all potential users with 3½ inch floppy disks sent through the mail or as magazine inserts, then AOL continued its carpet bombing with CD-ROMs when they became the medium of choice. This technique was both unique and positively received as the masses became more technologically savvy. Although this led to large-scale churning, the overall results worked well and subscribers increased by leaps and bounds. In order to minimize users leaving once they began to use AOL, they made it difficult to leave. When, as time passed, more and more subscribers decided that AOL was no longer the ISP that was needed; the courts agreed that this technique was unjust. Several million dollars were paid in penalties and costs by AOL as a settlement for this draconian practice. In addition, AOL was found to inflate its advertising revenues and this accounting misdeed resulted in payments of several billion dollars to settle a class-action suit in this regard.

How did this very successful venture turn so bad so quickly? The answer can best be summarized as entropy! A look at its inability to allow for interchanges at the cultural and social system levels as have been delineated by Talcott Parsons led to rapid deterioration within the Goal Attainment and Latency "functional requisites."

For entropy to be prevented there must be a proactive and open interchange among the primary system and all of its supra and infra contemporary systems as well as subsystems. The environment in today's business world is multifaceted and complex. Also, not to be ignored is the plexus of subsystems which exist within any system.

GROWTH

Kara Swisher (1998, p. xv) opens her book with a vignette which would position us at the personality system in the Parsonian "cybernetic hierarchy of control." It is the personality level that has "power" as its "generalized medium of exchange" (Turner & Maryanski, p.82) and its base "functional requisite" is goal attainment. The vignette is entitled "Meet Mr. Bill," and takes place in May of 1993. The opening paragraph reads "I can buy 20 percent of you, began Bill Gates in a most reasonable and even tone, a tone that was flatly matter-of-fact, neither angry nor blustery. The legendary co-founder of the software giant Microsoft Corporation rocked back and forth as he spoke; his hands touched lightly, forming a ten-fingered globe. The pose ---- which would become much more famous over the next few years --- struck one person in the small stuffy room as vaguely comforting, as if Gates were a learned sage about to impart the ultimate wisdom to the thick-headed masses gathered before him." (Swisher, p. xv). It continues "I can buy 20 percent of you or I can buy all of you, or I can go into this business myself and bury you."

This statement is directed at Steve Case who was the CEO of AOL. At the time AOL had about one-half of a million subscribers and had yet to begin its ascent into the large company that it would become. The medium of power is obvious and this vignette sets to goals for both Case and Gates. (Gates does not buy any part of AOL but decides to put into motion the creation of MSN, his answer to AOL.) Initially, the goal for Gates is to "bury" AOL, and for Case the goal is simply survival. The next ten years tell us much. MSN, although marginally successful, does not "bury" AOL and indeed, AOL reaches its peak of 34 million members in 2002. In this instance the energy from the personality system flows to the social system (for all of the specific steps toward the organizational development of the enterprise) and then the energy from the enterprise flows to the cultural system which allows AOL to become the accepted and most powerful ISP and indeed, force which at this point in time structures the Internet as well as the World Wide Web.

DECLINE

The decline begins at the Cultural level. There were cultural changes occurring (some subtle, others open and overt) which, in most cases, were ignored or overlooked that led to the dismantling of the AOL empire. These changes, since they were inextricable intertwined with emerging technology, were classic examples of "Cultural Lag" (Ogburn) which in turn exacerbated the dismembering of AOL.

First was the emergence of broadband. As cable providers and telephone companies (through DSL) began to provide high-speed internet connectivity, users began to drift away from "dial-up" connections. In addition, these high-speed providers offered their own free portals to the Internet, making belonging to a specific ISP less important. These portals were often supplied by other internet services such as Yahoo, Excite, or Google, which often allowed the end-user to configure and individualize his/her own home page, in an easy-to-do manner. By this time even those slow to adopt computers and internet utilization became much more comfortable with "low-cost" dial-up companies such as NetZero and EarthLink (in the late 1980s there were over 400 ISPs which increased to more than 7000 in the late 1990s (Cooper, 2002)). Thus, all of sudden there are numerous available internet portals along with a variety of prices and services. On the Cultural level the "killer application" appears which is the Internet. Individuals now think nothing of purchasing a Personal Computer if only to have access to the Internet. For the majority of the population the computer and the Internet become both desired and necessary. This was a big cultural obstacle which within twenty years is taken for granted even by the most reluctant adopters.

With broadband, information is easy to get and it can be attained faster. This of course gave rise to early "search engines," e.g., Archie, Gopher, etc., which facilitated the Internet as an information purveyor. Once the culture accepted the PC and then the Internet, the Social Systems sprang up to support, expedite, and simplify its usage even further. Other inventions such as the personal information manager and the cell phone made "text messaging" and instant communications by voice preferred to the "instant messaging" of AOL. In addition, with wireless communication everywhere the need for AOL in its traditional "dial-up" mode became superfluous.

Mergers between two technological companies often result in dysfunction, with the corporate culture of one often prevailing to the expense of the other. The classic early example of this would be Sperry and Burroughs to form Unisys. Unisys tends to retain the corporate culture of Sperry while the Burroughs corporate culture was largely subsumed by Unisys. This phenomenon was exacerbated when AOL merged with Time Warner (two very different corporate cultures) in 2001. This resulted in disaster with AOL Time Warner reporting a $99 Billion loss in 2002, the largest loss, at the time, ever reported by a company.

So, in addition to the entropy caused by AOL not paying careful attention to the occurrences in its own area (effectively the developments within and around the Internet were disregarded), AOL did not give proper consideration to the ramifications of a merger with Time Warner. It appears as if Steve Case became self-involved and lost focus in order to gain perceived power, a fact very well documented by Nina Munk in her book Fools Rush In (2004). The principals, Steve Case, Jerry Levin, Ted Turner, and Dick Parsons, were motivated by power, their attention was on the Personality System and, for all practical purposes, the Social and Cultural Systems were neglected. In this situation the vital resource keeping the "General System" viable was information, itself. When the egos of the main participants of the "General System" made the Personality System the primary driving force of the enterprise to the exclusion of the other major phases the equilibrium of the entire system is disturbed and entropy rapidly deteriorates that system.

CONCLUSION

The classic GST article written by Fremont E. Kast and James E. Rosenzweig is dissected and employed in this paper to explain the radical rise of AOL from a start-up company to a $200 million power with 34 million members to an inconsequential enterprise which is struggling to remain in existence. There were two key concepts from the article which were reflected upon in order to expedite the explication: 1) the phenomenon of entropy; and, 2) the assessment of the three levels on analysis (environment, social organization as a system, and the level of subsystems (human participants) within the organization. In order to better apprehend and understand the systems, the theory of Talcott Parsons was applied to this assessment.

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MESSAGE ROUTING PROBLEMS WITH TRAFFIC BASED SCHEDULING IN NETWORKS

Dinesh K. Sharma, University of Maryland Eastern Shore
dksharma@umes.edu
S. K. Peer, K.S.R.M. College of Engineering
skp_ksrm@yahoo.co.in

ABSTRACT

This paper presents a methodology in which message release/delivery times are based on the traffic rate of messages on the links for the transfer from a source node to a sink node. The corresponding capacity constrained linear multi-commodity flow problem is formulated, and solved as a relaxed linear programming problem. Further, the randomized rounding technique is applied to the resultant solution, to determine the optimal message transfer path from source node to sink node. The results of the proposed methodology are compared with that of an existing methodology for an illustrative example presented in the literature.

1. INTRODUCTION

A good routing algorithm is essential for sustaining the proper functioning of a network (Guimera et al., 2001; Moreno, et al., 2003; Motter, 2004; Yan et al., 2006). There are several routing algorithms for both static and adoptive routing. The waiting time depends on the number of packets (messages) or traffic in the queue at a neighboring node at the time of decision and corresponds to time-dependent information (Zhang et al., 2006). The message route is determined during message transmission to adapt to the current network traffic or other conditions, such as node or link failures (Ahuja, 1985). Under appropriate assumptions, the problem of determining the optimal routes for message transmission is formulated as a class of non-linear convex multi-commodity flow problems (Fratte et al, 1973; Bertsekas and Gallagers, 1987). Decomposition methods identify easier sub problems for which polynomial algorithms can be coded, such as shortest path and minimum cost flow computations (Ouorou et al, 2000). The Flow Deviation method (Leblanc, 1973; Fratta et al., 1973), the Projected Newton method (Bertsekas et al., 1984; Bertsekas and Gallagers, 1987), the Analytic Center Cutting Plane Method (Gaffin et al., 1997) and the Proximal Decomposition Method (Mehey et al., 1998) are the main algorithms used in both transportation and telecommunications networks. These algorithms belong to the family of Cutting Plane Methods and distributed algorithms of the proximal point algorithm (Rockafellar, 1976).

Greenwald and Dean (1996) explored a transmission problem for package routing in which the schedules of the vehicles are fixed and packages are routed by transferring them between vehicles as these vehicles make stops according to their fixed schedules. Greenwald and Dean (1996) also reformulated the capacity constrained package transfer problem as a multi-commodity flow problem, and the approximation algorithms developed from the randomized rounding technique of Raghavan and Thompson (1987, 1988) were used to obtain the solutions.

In this study, we propose a methodology to compute the message (package) transfer path in which schedules of message release and delivery at nodes are based on the traffic rate. The message (package) routing problem is formulated as a capacity constrained linear programming model, and the randomized rounding technique of Raghavan and Thompson (1987, 1988) is used to obtain a single path for transferring a message from source node to sink node. The methodology is applied to an illustrative network as presented in Greenwald and Dean (1996) and results are compared.

2. CAPACITY CONSTRAINED MESSAGE TRANSFER PROBLEM

The message transfer problem in communication networks is dependent on the geometry of the underlying network, the message generation and delivery rate, and the routing strategy. The message transmission time (t_{ij}) for the given arrival rate of messages (λ_{ij}) between the pair of nodes i and j is computed as follows (Ahuja, 1985):

$$t_{ij} = 1 / (uL_{ij} - \lambda_{ij}) \quad (1)$$

Where, λ_{ij} = Arrival rate in number of messages per unit time on to the link (i, j)

L_{ij} = Capacity of the link (i, j) and

$1/u$ = Average message length in number of bits per message.

Generally, the messages are required to wait at the nodes until the outgoing links to the adjacent nodes are identified send the message to the destination.

To prepare message release and delivery schedules at the nodes, the duration of delay for each message at the nodes is considered. A time–space transformation is provided to express discrete time problems of capacity constrained message transfer as integral multi–commodity flow problems (Greenwald and Dean 1996). As a result, the induced flow graph G' = (V, E), where V is set of vertices and E is set of edges based on the pre-specified routes in the network, is constructed using the message (package) release and delivery schedules. Then, the multi–commodity flow problem is formulated as a capacity constrained linear program to minimize the total message transmission time in a network based on the capacity requirement of the message on each link as follows (Greenwald and Dean, 1996):

$$\text{Minimize } Z = \sum_{p \in P} \sum_{e \in E} Cost_e X_{pe} \quad \text{(Performance criterion/ objective function)} \quad (2)$$

Subject to:

$$\sum_{p \in P} R_p X_{pe} \leq Cap_e \quad \text{(Capacity constraint for each } e \in E) \quad (3)$$

$$\sum_{(u,v) \in E} X_p(u,v) - \sum_{(v,w) \in E} X_p(v,w) = 0 \quad \text{(Conservation of flow constraint) for each } p \in P,\ v \in V - \{s_p, t_p\} \quad (4)$$

$$\sum_{(u,t_p) \in E} X_{p(u,t_p)} - \sum_{(t_p,u) \in E} X_{p(t_p,u)} = 1 \quad \text{(requirement delivery constraints) for each } p \in P \quad (5)$$

$$0 \leq X_{pe} \leq 1$$

Where, Cap_e & $Cost_e$ are the capacity and cost (time), respectively of edge $e \epsilon E$ in the flow graph.

X_{pe} ϵ [0, 1] be the variable describing the fractional flow of message (package) p assigned to edge e, i.e., if message (package) p could be divided into arbitrarily small pieces, the fraction that would be assigned to any given edge in the flow graph.

V = Set of nodes in the flow graph.

E = Set of edges in the flow graph.

s_p and t_p are source node and sink node respectively.

R_p = Requirement capacity for message (package)p.

$Cost_e$ = Delivery time of message – relieved time of message on each edge $e \epsilon E$.

This relaxed linear programming problem is solved to satisfy all the constraints. The solution describes a fractional flow of messages (packages) through the flow graph. This solution minimizes the mini-sum performance criterion. Then, the randomized rounding technique of Raghavan and Thompson (1987, 1988) is used to determine the message transfer path. The randomized rounding technique produces high probability approximations for integer problems by first solving a relaxed liner program and then using the resulting real number values to determine integer values for the variables (Greenwald and Dean, 1996).

The basic steps involved in the proposed methodology to determine the message (package) transfer path from the given source node to sink node for all the messages in a network are given in Fig.1.

3. AN ILLUSTRATIVE EXAMPLE

The example network of Greenwald and Dean (1996) is considered to demonstrate the proposed methodology (Fig.2). The message lengths and destinations are given within the nodes, whereas the capacities of the links are given within the parentheses. The arrival rates of the messages are given over the links. It is assumed that the arrival rate is equal to the traffic rate on the links. It is also assumed that the message is required to wait for 1 second in order to identify its out going links to reach the destination node. The message transfer routes are identified as $A \rightarrow C \rightarrow B \rightarrow A$; $B \rightarrow F \rightarrow E \rightarrow F \rightarrow B$; and $E \rightarrow D \rightarrow C \rightarrow B \rightarrow A \rightarrow E$. The messages are assumed to start at time t = 0, and equation (1) is used to compute the schedules as given in Table 1 for the example network in Fig.2 (Fig.2 is available with authors). The performance criteria of this problem is to find a set of schedules for messages, such that the total time between release and delivery at sink node is minimized subject to the capacity constraints on the links, and requirement constraints at the intermediate nodes.

Table 1: Schedules based on traffic rates on the links

	First stop on route	Second stop on route	Third stop on route	Fourth stop on route	Fifth stop on route	Sixth stop on route	Cycle time in seconds*
A-C-B	0.00(A)	0.088(C)	1.256(B)	repeat			2.314
B-F-E-F	0.00(B)	0.33(F)	1.66(E)	3.16(F)	repeat		4.66
E-D-C-B-A	0.00(E)	0.25(D)	1.50(C)	2.67(B)	3.73(A)	repeat	4.98

* *Cycle time assumes* 1 *second waiting time per stop.*

The following section presents the formulation of the problem and its solution procedure.

3.1 Problem Formulation

A cost is associated with traversing an edge corresponding to delivering a message (package) from one location to another along a direct route, starting at a particular time. A cost is associated with traversing an edge corresponding to waiting at a location at a particular time (Greenwald and Dean 1996). For each message (package) p, the cost is delivery (p) – relieved (p). This cost can be decomposed into a series of costs representing the time needed to travel a particular leg of the trip or the time spent waiting at the node. For the induced flow graph shown in Fig.3 (The Fig.3 is available with authors), the time interval T_0 of this example is {0.00,…,9.04}, to capture all package routing activity. The edge between two locations is marked by a directed arc. Costs for edges are implicit in the distance across time of each edge in the graph. Locations are represented by nodes in row r, and column c, where r = A, B, C, D, E, F, and c = 0.00, 0.09, 0.25,..., 9.04. Let the location $l_{r,c}$ represent the node in the rth row and cth column, and ($l_{r,c}$, l_{r^1,c^1}) represent the edge between the pair of nodes (r, c) and (r^1, c^1). The locations l_A, 0.00; l_B, 0.00;….; l_F, 0.00 are the source nodes, and l_A, l_B, l_C, l_E, and l_F are sinks, excluding D, since D has no commodity as sink.

The message-wait edges between the locations ($l_{A, 0.00}$, $l_{A, 2.35}$), ($l_{A, 2.35}$, $l_{A\ 3.73}$), ($l_{A, 3.73}$, $l_{A, 5.69}$), ($l_{A, 5.69}$, $l_{A, 9.04}$), ($l_{B, 0.00}$, $l_{B, 1.26}$), ($l_{B, 1.26}$, $l_{B, 2.67}$), ($l_{B, 2.67}$, $l_{B, 4.63}$), ($l_{B, 4.63}$, $l_{B, 4.66}$), ($l_{B, 4.66}$, $l_{B, 7.98}$), ($l_{B, 7.98}$, $l_{B, 8.71}$), ($l_{B, 8.71}$, $l_{B, 9.04}$), ($l_{C, 0.00}$, $l_{C, 0.09}$), ($l_{C, 0.09}$, $l_{C, 1.50}$), ($l_{C, 1.50}$, $l_{C, 3.43}$), ($l_{C, 3.43}$, $l_{C, 6.78}$), ($l_{C, 6.78}$, $l_{C, 7.49}$), ($l_{C, 7.49,}$, $l_{C, 9.04}$), ($l_{D, 0.00}$, $l_{D, 0.25}$), ($l_{D, 0.25}$, $l_{D, 6.26}$), ($l_{D, 6.26}$, $l_{D, 9.04}$), ($l_{E, 0.00}$, $l_{E, 1.66}$), ($l_{E, 1.66}$, $l_{E,5.01}$), ($l_{E, 5.01}$, $l_{E, 7.32}$), ($l_{E, 7.32}$, $l_{E, 9.04}$), ($l_{F, 0.00}$, $l_{F, 0.33}$), ($l_{F, 0.33}$, $l_{F, 3.16}$), ($l_{F, 3.16}$, $l_{F, 5.99}$), ($l_{F, 5.99}$, $l_{F, 8.82}$), and ($l_{F, 8.82}$, $l_{F, 9.04}$) are designated as A1, A2, A3, A4, B1, B2, B3, B4, B5, B6, B7, C1, C2, C3, C4, C5, C6, D1, D2, D3, E1, E2, E3, E4, F1, F2, F3, F4 and F5 respectively. The message-sink edges between the locations ($l_{A, 2.35}$, l_A), ($l_{A, 3.76}$, l_A), ($l_{A,5.69}$, l_A), ($l_{A,9.04}$, l_A), ($l_{B, 1.29}$, l_B), ($l_{B, 2.70}$, l_B), ($l_{B, 4.63}$, l_B), ($l_{B, 7.98}$, l_B), ($l_{B, 8.71}$, l_B), ($l_{C, 0.09}$, l_C), ($l_{C, 1.50}$, l_C), ($l_{C, 3.43}$, l_C), ($l_{C, 6.78}$, l_C), ($l_{E, 1.66}$, l_E), ($l_{E, 5.01}$, l_E), ($l_{E, 7.32}$, l_E), ($l_{F, 0.33}$, l_F), ($l_{F, 3.16}$, l_F), ($l_{F, 5.99}$, l_F), and ($l_{F, 8.82}$, l_F) are designated as A01, A02, A03, A04, B01, B02, B03, B04, B05, C01, C02, C03, C04, C05, E01, E02, E03, F01, F02, F03, and F04 respectively.

The flow edges ($l_{A, 0.00}$, $l_{C,0.09}$), ($l_{B, 0.00}$, $l_{F, 0.33}$), ($l_{E, 0.00}$, $l_{D, 0.25}$), ($l_{C, 0.09}$, $l_{B, 1.26}$), ($l_{D, 0.25}$, $l_{C, 1.5}$), ($l_{F, 0.33}$, $l_{E, 1.66}$), ($l_{B, 1.26}$, $l_{A, 2.35}$), ($l_{C, 1.5}$, $l_{B, 2.67}$), ($l_{E, 1.66}$, $l_{F, 3.16}$), ($l_{A, 2.35}$, $l_{C, 3.43}$), ($l_{B, 2.67}$, $l_{A, 3.73}$), ($l_{F, 3.16}$, $l_{B, 4.66}$), ($l_{C, 3.43}$, $l_{B, 4.63}$), ($l_{A, 3.73}$, $l_{E, 5.01}$), ($l_{B, 4.63}$, $l_{A, 5.69}$), ($l_{B, 4.66}$, $l_{F, 5.99}$), ($l_{E, 5.01}$, $l_{D, 6.26}$), ($l_{A, 5.69}$, $l_{C, 6.78}$), ($l_{F, 5.99}$, $l_{E, 7.32}$), ($l_{D, 6.26}$, $l_{C, 7.49}$), ($l_{C, 6.78}$, $l_{B, 7.98}$), ($l_{B, 7.98}$, $l_{A, 9.04}$), ($l_{E, 7.32}$, $l_{F, 8.82}$), ($l_{C, 7.49}$, $l_{B, 8.71}$), and ($l_{B, 8.71}$, $l_{A, 9.04}$) are designated with their capacities within the parenthesis as 1(40), 2(20), 3(30), 4(40), 5(30), 6(20), 7(40), 8(40), 9(20), 10(40), 11(40), 12(20), 13(40), 14(30), 15(40), 16(20), 17(30), 18(40), 19(20), 20(30), 21(35), 22(40), 23(20), 24(30), and 25(30) respectively.

The various edges used to transfer these fractional flows to the nodes A, B, C, E, and F. It is sufficient to set the message(package)-sink-edge and message(package)-wait-edge capacities equal to the sum of all message (package) requirements, rather than to infinity (Greenwald and Dean, 1996). In this paper, the capacities of the message (package)-sink-edge and message(package)-wait-edge are assumed as 50 and 60 respectively. The time (cost) of the message (package)-sink-edges created are set to zero (Greenwald and Dean 1996). The capacity requirements (R_p) for two messages (packages) in the network are assumed to be 6 and 5 for p=1 and 2 respectively. In order to transfer the message 1 and message 2 between the pair of nodes A and B, B and F, F and E, E and C, and C and A , the data of the network problem shown in Fig. 2 is used in the set of equations (2) to (5). The resulting system of equations of the relaxed linear program is solved to determine the fractional flows of two messages assigned to the various edges in the flow graph. A solution obtained in terms of the fractional flow of messages through the flow graph satisfies all the constraints of the relaxed linear programming problem. The components correspond to the fraction of each message assigned to a leg of its route or required to wait at a location.

The feasible, though not necessarily optimal solutions to assign the fractional flows of message 1 to the various edges in the flow graph in order to transfer the message from A to B is given in Fig. 4 (Greenwald and Dean 1996). The solution describes a fractional flow of messages (packages) through the flow graph. If the message could be broken up into arbitrarily small pieces and then reassembled at the sinks, this solution would be optimal (Greenwald and Dean 1996). The path stripping and randomized rounding phases show that messages can not be split up this way (Greenwald and Dean 1996). The path stripping and randomized rounding phases are applied to the fractional flow of message 1 that must go from A to B in order to determine the path of message 1.

3.2 Path Stripping Phase

The path stripping procedure assigns a flow value to each possible path (with non zero flow), corresponding to the largest possible common flow across all edges of the path (i.e., the minimum flow on any one edge in the path) of each package in the flow graph (Raghavan and Thompson 1987). A path is assigned a value and the path stripping technique merely re-labels the solution from an edge based flow to a path - based flow without changing the solution.

3.3 Randomized Rounding Phase

The randomized rounding procedure selects one and only one path for each $p \in P$, to transport all of the message (package) p from a source to a sink. This phase chooses a single path for each message (package), independent of other messages (packages), based on the probability produced by path stripping (Greenwald and Dean 1996). One possible path selected from the set of 5 paths is along the edges 1, 4, and B01 with probability of 0.4, using the randomized rounding technique. The capacity requirement constraints are not violated. This path indicates that the message 1 (package 1) is delivered from A to B via C, whereas the path selected in the solution obtained by Greenwald and Dean (1996) indicates a period of waiting followed by delivery from A to B via C.

Due to the space limitations, other figures and data tables will be reported upon presentation of the paper.

4. RESULTS

The results of the proposed methodology indicate that the path from A to B via C is selected to transfer the message 1 (package 1), whereas the results of Greenwald and Dean (1996) in which the schedules of the message release and delivery are fixed, indicate a waiting of the message followed by transfer from A to B via C. The solution of the relaxed linear program is used to determine the transfer path of message 2 also from A to B. Similarly, the solution is also used to determine the transfer paths of messages 1 and 2 from B to F, from F to E, from E to C, and from C to A.

5. CONCLUSION

In this paper, a methodology is presented to determine the message transmission route from source to sink in which the message release and delivery times are computed based on the arrival (traffic) rate of messages (packages) on to the link. The methodology is applied to the network presented by Greenwald and Dean (1996), in which the schedules of message release and delivery are fixed to determine the route of the message from source to sink. The problem is formulated as a relaxed linear program and solved. Then, the randomized rounding technique of Raghavan and Thompson (1987, 1988) is used to obtain the path for transmission of the message (package) from source to sink.

REFERENCES

(A complete list of references is available upon request from Dinesh Sharma at dksharma@umes.edu)

CURRENT STATE OF IT SECURITY IN ORGANIZATIONS

Santosh S. Venkatraman, Tennessee State University
svenkatraman@tnstate.edu

ABSTRACT

Information technology is a very important tool for all modern organizations. Unfortunately, as more IT systems are deployed, networked better, and easier to access (wireless), they also become more vulnerable targets for sabotage. This paper will describe the major consequences of security breaches, new IT security risk factors as perceived by organizations and their leaders, and also identify impending threats that should be taken more seriously.

INTRODUCTION

Information Technology is clearly a necessity for most organizations, and is certainly a powerful tool to become more efficient and maintain business competitiveness. The usefulness and ubiquitous nature of IT also makes organizations very dependent on IT systems, and therefore extremely vulnerable to failures – both, due to system flaws and/or computer-criminals. The subject of this paper is primarily the latter case in which IT systems are compromised due to security lapses.

Organizations are aware of the security problem and taking measures to protect themselves. IT security, however, is a moving target, and criminals are constantly finding new ways to compromise systems, defraud customers and organizations, and cause them to fail. The purpose of this paper is to study the major consequences of security breaches, and list the newer security threats and issues in the information technology sector. This paper will be beneficial to academic researchers as it will provide a basis for conducting relevant research in the IT security area. Business managers in organizations will benefit from the paper, as it would make them aware of modern security threats, and potentially help them reduce security vulnerabilities in their organizations.

IT SECURITY ISSUES & THREATS

Before the major threats are identified, it is important to realize the various financial consequences of poor security policies and systems in an organization.

Unreliable Systems. If the IT system is not secure, there is no assurance of the quality of data that is maintained on the system. Data records cannot be trusted as they could have been altered without knowledge (intentional or otherwise). Bad information could likely lead to bad managerial decisions

Unauthorized Access By Employees. An insecure system tempts Employees to illegally gain access to classified or privileged information. This is especially a dangerous situation when an employee is disgruntled, and wants to harm the organization.

Reduced Employee Productivity. An insecure IT system needs a lot of maintenance, and IT personnel will be constantly “putting out fires.” The end result is a lot of system downtime resulting in employees not being able to work productively (for example, do things manually, instead of the automated system)

Financial Embezzlement & Lost Revenue. In adequate security is an open invitation for financial fraud, and lost revenues as customers will be unable to complete transactions.

Theft of Customer Records. Customer Id Theft is a major issue, and can result in lawsuits and/or Customer Loss.

The Global State of Information Security [2006] worldwide study by Pricewaterhouse Coopers, the Chief Information Officer (CIO), and the Chief Security Officer Publications revealed a startling fact that global information technology executives are still novices when it comes to many of the leading issues in security, and are still engaging in behaviors that could have potentially disastrous consequences to the organization. The financial impact of security lapses is difficult, if not impossible, to gauge in the short term, especially when it involves the theft of data. Not surprisingly, the highest percentage of respondents admitting to a security breach, about 35% in the United States, say that they don't know the total value of the loss they suffered. CIOs and CISOs (Chief Information Security Officers) are not completely oblivious of their security problems - they are rapidly ramping up their security budgets, which increased from 11% to 17% of their IT budgets from 2004 to 2006. Major “new” threats identified by organizations include:

SQL-Injection - A programming technique applied to Web site requests, SQL injections have one purpose: to steal information from databases accessed by Web applications.

Wireless/RFID Attacks – Increased Use wireless networking technology opens up stealth attacks.

BotNets – automated, rapid attacks using a distributed network of computers on the Internet results in devastating results and makes it hard to identify the source of attack.

Phishing & Farming. Customers lured by “authentic-looking” websites and emails, and inadvertently revealing their sensitive data such as password, user-id, social-security numbers, and so forth.

To counter the increased intensity, impact, and frequencies of security attacks on their IT systems, organizations are developing many additional policies and measures (in addition to the usual such as user-ids, site-keys, and VPN digital tokens) such as:

Increasing User Awareness - Organizations conduct more seminars, place more security – policy documents on the Intranet, and provide additional, better-trained support staff for helping employees.

Better Policy Enforcement – In the past, many security policies were proposed and implemented, but enforcement was still inadequate – stricter enforcement will give a clear message hat security is a top-priority, and serious issue.

Assessing Security Risks - Develop and use better methods to assess the impact of security breaches, so that adequate, realistic funding can be allocated for security measures (better ROI metrics).

SUMMARY & CONCLUSIONS

IT security Issues will only get worse and more sophisticated with time, so all organizations should be aware of this "time bomb," take adequate measures to protect themselves, and be prepared for dealing with security attacks. This paper opens up a very fertile field for doing research, as the threats are real, important, and expensive, and will always be there to be dealt with. Business continuity measures and pre-emptive security policies and measures are also imperative for future survival, and god areas to conduct future research.

REFERENCES

Available Upon request