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STUDENTS' PERCEPTION OF LEARNING STATISTICS: COMPARING EXCEL WITH MINITAB

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ABSTRACT

An investigation was undertaken of students' perception of benefits they receive working statistical problems with larger data bases using Excel as compared to Minitab. A questionnaire was administered to students completing the second (Advanced) statistics course at the end of the fall semester, 2003, using a Likert scale from 1 (strongly disagree) to 7 (strongly agree) . An analysis of the results indicates that students considered themselves familiar with Excel at the beginning of the semester, but not with Minitab. They were indifferent as to the benefits of any kind of software in the course, and generally preferred to use manual calculations rather than software. They disagreed with the statement that they retained more knowledge of statistical techniques using any kind of software than with manual calculations. They were indifferent as to the enhancement of their understanding of statistics by using either Excel or Minitab. They were, on average, indifferent to the statements that Excel was more helpful than Minitab in a variety of statistical procedures.

A MODELING METHODOLOGY FOR DYNAMIC STORAGE REALLOCATION WITH COST MINIMIZATION

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ABSTRACT

In computer information systems, some programs are used more frequently than others producing skewed distributions of program usages. We investigate the claim that static views of program usage frequencies are insufficient when they are used for storage allocation decisions making it necessary to study the implications of the use of dynamic frequencies in storage allocation.

The use of dynamic frequencies provides a natural extension to previously presented static cost model literature for hierarchical storage allocation. In our work, we present the value of incorporating dynamic usage frequencies into program usage cost models. Thus, an optimization-based cost modeling methodology using Simon's Model for dynamic hierarchical storage allocation is presented.

INTRODUCTION

One problem faced by organizations in today's rapidly changing field of computer information systems is the consumption of storage capacity due to the growing base of software assets. Research has shown that very few firms effectively monitor program usage (Willet, 1994). Storage management issues arise when many of the programs occupying valuable storage space are used infrequently. Many IS managers simply buy more primary storage when they feel it is necessary instead of performing maintenance.

Many application programs in a firm are subject to decreases as well as increases in usage rates. The problem is that the usage rate of an individual software item is dynamic. There is no feasible way to predict the behavior of each individual program in an organization. Instead, it is more practical to provide a methodology for focusing on those programs whose changing usage is critical to storage allocation and cost minimization.

With a better understanding of normal program usage behavior, organizations can develop policies based on easily understood criteria. Simon's Model has been well studied in literature concerning information usage (Simon, 1991). Program usage can also be studied using the model, making it the tool of choice to develop such criteria. In turn, we will show that it is possible to create organizational policy based on program usage observations.

The true value in deriving a policy using Simon's Model is the relative ease that an organization can assess its own model parameters. Once model parameters are evaluated, a firm would be able to determine the category into which their software falls. Each category would provide a recommendation for the intervals at which the "significant few" should be assessed for usage. The cost of storage allocation could then be minimized.

SUPPORTING LITERATURE

While investigating various algorithms developed for the purpose of optimizing storage in multi-level storage systems, it was found that the models developed by P. Chen (1973) and Ramamoorthy & Chandy (1970) assumed a static, or constant, usage frequency. Both models are optimization models that serve to either minimize storage cost or minimize average access time. The focus of Chen's model was on the placement of files using various types of storage devices that minimize cost. In the work of Ramamoorthy & Chandy, their model involved the placement of programs and associated data in a storage hierarchy to minimize access time.

General observations from the study of Simon's Model indicate that it is possible to isolate dynamic usage scenarios prevalent in organizational program usage behavior (Simon, 1968). Simon's model provides us with a powerful mechanism for studying program usage scenarios. Therefore, we adapt the model in a dynamic way by expressing α (alpha - an increasing usage rate) and γ (gamma - a decreasing usage rate) as functional values. This adaptation provides us new insight into the interrelation of program entry and program aging (Simon, 1991).

By incorporating Simon's Model, we have the ability to categorize usage patterns. For example, we can determine which software programs fall into the category of the "trivial many." Research thus far indicates that in many firms at least 80% of programs fall into this category (Willet, 1994). Thus, in most organizations, a very large portion of programs can be eliminated from the group requiring maintenance attention. Additionally in many organizations, there is usually a very small portion of programs whose usage consistently remains in a high usage ranking position. It would also be reasonable to eliminate these programs from the group requiring maintenance since they show little to no decay in usage.

Once the group of programs of concern in the "significant few" is identified, it then becomes valuable to examine the changes in their usage. In order for organizations to have the ability to establish a policy for better management of their storage assets, we extend the research of P. Chen and Ramamoorthy & Chandy. We develop and present the methodology: Dynamic Storage Reallocation with Cost Minimization, a cost-oriented optimization model for the assignment of programs to various levels of storage.

THE OPTIMAL STORAGE ALLOCATION HIERARCHY MODEL

The model developed here is targeted toward the placement of programs in different storage media, but it is also applicable to the placement of data. We have chosen to concentrate on program storage in order to accommodate programs consisting of a variable number of memory blocks that are assigned to a single storage medium. If data files are considered in the storage hierarchy, then

one can assume that the data can be divided into equal size blocks, and blocks of the same file may be stored on different devices in the memory hierarchy.

Model Assumptions

1. Let M denote the total number of devices in the storage hierarchy.
2. For each device j , the cost per block is C_j for devices $j = 1, 2, \dots, M$. It is assumed that C_j is a known, constant value. Also, it is proportional to the efficiency with which the program can be retrieved from storage. That is, a program stored in primary storage will have a higher associated cost per block than a program that is stored in some other secondary storage device. Cost figures for the use of primary and secondary storage devices are generally expressed in dollars per megabyte. Ghandeharizadeh, Ierardi and Zimmerman (1994) make reference to costs associated with such storage options.
3. Let L denote the total number of programs, where each is stored in a file consisting of N_i blocks for $i = 1, 2, \dots, L$. Assume that the blocks of a program cannot be separated from the program file on different media. Namely, blocks of a program file cannot be divided between several storage devices.
4. Suppose that decision variable $X_{ij} = 1$ if program i is assigned to device j , or 0 if program i is not assigned to device j . Thus:

$$\sum_{j=1}^M X_{ij} = 1.$$

5. Let f_i be the reference frequency for program i in per unit time. Here, the time unit is expressed in terms of cycles, where a cycle is defined as the number of total usages over an observed distribution of frequencies. Thus, the total request rate (λ_j) for device j is:

$$\lambda_j = \sum_{i=1}^L f_i X_{ij}.$$

We assume here that a single program is allocated to only one storage device, and any usage frequency profile (f_i) will reflect only the usage history since the previous allocation.

6. It is assumed that one program is transferred per input/output request. The service time for each device is presumed to be a random variable that varies accordingly for input/output requests due to the electromechanical nature of storage devices. Thus, request service time is assumed to be exponentially distributed with a mean of $1/\mu_j$ for $\mu_1, \mu_2, \dots, \mu_M > 0$, where μ_j is the service rate of device j . In order to prevent the queue length for requests from growing without bound, it is required that $\lambda_j < \mu_j$. Namely, the overall request rate to a device must be less than the service rate.
7. It is also necessary to define BS_j as the maximum allowable number of blocks that can be stored on device j . This is a constant value that is assigned as blocks of storage are added.

Minimum Cost Storage Allocation Model Formulation

From the assumptions stated above, a cost minimization model for the allocation of programs to various levels of storage can be stated as follows:

Minimize Cost

$$\sum_{j=1}^M C_j \sum_{i=1}^L N_i X_{ij} \quad (1)$$

Subject To

$$\sum_{j=1}^M X_{ij} = 1 \quad \text{for } i=1, \dots, L \quad (2)$$

$$\sum_{i=1}^L N_i X_{ij} \leq BS_j \quad \text{for } j=1, \dots, M \quad (3)$$

$$\sum_{i=1}^L f_i X_{ij} \leq \mu_j \quad \text{for } j=1, \dots, M \quad (4)$$

INCORPORATING SIMON'S MODEL FOR DYNAMIC STORAGE REALLOCATION

With insight gained through the study of dynamic usage frequencies of Simon's Model, we extend the static cost optimization storage allocation model presented above. We call this modeling methodology: Dynamic Storage Reallocation with Cost Minimization. The process for implementation is shown in Figure 1.

Insert Figure 1 about here.

CONCLUSIONS

Viewing program storage allocation as a dynamic process will not only affect storage costs, but also affect the placement of programs under some service time constraint. The methodology proposed in this research is a natural extension of the work by P. Chen and Ramamoorthy & Chandy, though it does have significant differences from those developed by the aforementioned authors. We have not taken into consideration mean response time constraints for individual storage requests, nor have we considered the possibility of allocating blocks of one file to different storage media. Both considerations present opportunities for future research.

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KNOWLEDGE MANAGEMENT ISSUES FOR HIGHER EDUCATION

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ABSTRACT

This research proposal serves to explore various facets of the concept of Knowledge Management (KM). KM has typically been thought of as the collection of technological assets and managerial policies that compensate for information failures. The popularity of the KM topic stems from the fact that organizations have become too big for personal information sharing to take place. Thus, we explore the evolution of KM and many of its common practices. An attempt is made to bridge the gap between the common practices of KM and the hidden areas in organizations where knowledge cannot easily be captured. In particular, the relevance of this topic in higher education institutions is proposed for investigation, where KM can hopefully create more opportunities for those involved in administration.

INTRODUCTION

The concept of Knowledge Management (KM) has been around for decades, but most organizations accept it only as theory and have not put it into practice. It has been difficult for many organizations to evolve their organizational thinking from an information focus to a knowledge focus. Throughout the past several decades, Information Systems practices were sufficiently developed to accomplish efficient production of information. Problems arose when information was in abundance, but key individuals possessing that information did not or would not share it with others who stand to benefit from its discovery.

The Gartner Group, and international technology consulting group, defines and offers KM as a discipline that encourages a mutually supported method to create, capture, organize, and use information (Duffy, 2000). From a more intuitive standpoint, it is using technology, programs, policies, and management processes to compensate for the fact that organizations are too big for everyone to know each other and share information at a person-to-person level (Novins, 2000). Therefore, necessary incentives must be put into place in order for KM to be viewed by organizations as an asset that goes beyond the value of their available information.

This research proposal provides a survey of common interpretations of KM, a summary of the evolution of KM, and explores the characteristics of good KM systems. There has been some recent investigation into how educators might use KM to enhance or create effective learning environments. It is of particular interest to examine the need for KM practices in institutions of higher learning. We explore the alternate view of enhancing the administration environment of higher education by identifying common practices inhibiting the widespread deployment of KM.

WHAT IS KNOWLEDGE MANAGEMENT?

Dunn and Neumeister (2002) define KM as a systematic approach to managing and leveraging an organization's knowledge asset, which may include knowledge of the organization's customer's, products, market, processes, finances and personal services. KM can be thought of as packaging the right content and delivering it to the right people who can make use of it at the right time (Novins, 2002). The effective use of KM involves a systematic process of finding, selecting, organizing, distilling and presenting information in a way that improves an employee's comprehension in a specific area. Ultimately, people must be enabled to collaborate with one another through the use of KM. The ability to let individuals share their ideas is an integral part of a KM solution that is meaningful.

REVIEW OF KNOWLEDGE MANAGEMENT

Dunn and Neumeister (2002) give a synopsis of the evolution of KM. They state that instances of KM may have first been recognized around the time of World War II. It was during this time that it became evident how workers learned from experience. For instance, it was noticed that building a second airplane took considerably less time than building the first.

In 1962, Nobel Prize-winning economist Kenneth Arrow addressed the issue of KM in his article entitled "The Economic Implications of Learning by Doing." It was during this same time period that resources began to be devoted to the cause of determining significant performance variations in output within organizations.

Attempts to increase organizational learning in the 1970s and 1980s included Information Management and Total Quality Management. Another set of practices that arose called the Human Capital Movement is based on the belief that investment in individuals through education and training has a high rate of return.

Although it is unclear when the term "Knowledge Management" was officially coined, its concept intensified in the 1990s. In 1993 Karl Wiig authored "Knowledge Management Foundations: Thinking about Thinking - How People and Organizations Create, Represent and Use Knowledge." This was possibly the first published use of the term.

CHARACTERISTICS OF GOOD KNOWLEDGE MANAGEMENT SYSTEMS

Peter Novins (2002), a vice president at Cap Gemini Ernst & Young, summarized the characteristics of KM in an E-Business presentation. His remarks were that good KM should have three characteristics. First, it needs to address a real business problem that everybody agrees is a

problem. Second, an organization cannot sustain a KM system without some kind of community interest or practice that provides content and accepts responsibility for continuing to build and share the content. Third, KM systems have to make it very, very easy for people to get the content they need.

KNOWLEDGE MANAGEMENT IN SCHOOL SYSTEMS

Thus far, KM has been presented as a practice that makes sense for organizations. It is the concept of combining the expertise, wisdom and insights of those individuals who have come to their wisdom the hard way. If the wisdom could be captured and shared within the community, it would make sense that organizations would benefit infinitely.

Certainly, this premise could be applied to organizations or institutions of all types. We choose to focus on the dynamics of KM in school systems. The continuous drive for improvement and accountability in education makes it a prime example of the need for knowledge repositories. State and federal funding for education at all levels is tightening while there is increased pressure for improvement and assessment of student outcomes (Miller, 2002; Ewell, 2002). Schools, colleges and universities are being called to a higher level of accountability in terms of mission and needs of students. In an article published by The Institute for the Study of Knowledge Management in Education, several barriers are discussed that make it difficult to use and share data and information effectively in educational institutions (Petrides and Nodine, 2003). These barriers include:

<i>Lack of Staff</i> - Schools do not always have enough qualified staff to provide proper analysis of raw data.
<i>Data Collection not Uniform</i> - Various departments within educational institutions often use different software and other means to collect and organize data.
<i>Lack of Leadership</i> - Many schools face high turnover rates among upper-level managers, which makes it difficult for them to remain consistent in using and sharing data and information.
<i>Lack of Integration of Technology</i> - Many teachers, faculty and staff adopt a "hands-off" approach to technology issues, leaving them to those who might know a lot about hardware, but very little about the information needs of people in the organization.
<i>Unclear Priorities</i> - Information collection and analysis is often isolated and not clearly related to the mission of the organization.
<i>Distrust of Data Use</i> - Many faculty members have witnessed the manipulation of data and are wary of any process that would have their work subject to institutional "bean counting."

School districts frequently employ an information architecture that is disjointed and counterproductive, not unlike the business environment (Petrides and Guiney, 2002). Combined with the above barriers is the issue of asynchronous "technology culture" and "information culture." Many schools are pouring millions of dollars into information technology without considering how to effectively integrate those technologies into shared decision-making processes to improve academics, operation and planning.

SPECIALIZED KNOWLEDGE MANAGEMENT IN HIGHER EDUCATION

Having explored the nature of KM in organizations and school systems, this research proposal focuses on the specific culture that causes barriers to effective KM in colleges and universities. Knowledge, in this context, is information that is further refined to connect, compare, evaluate and act on information. It also involves the experience and judgement of the individuals within the higher education organization.

The question is: "How can faculty and administrators in higher education be motivated to share the knowledge gained from their experience?" The typical culture in colleges and universities is not one that rewards sharing of ideas and wisdom. Promotion and job security are functions of a faculty member's ability to generate original ideas, and apply them in unique ways. In such a case, knowledge can be thought of as a belief that is justified and then internalized. Therefore, it can be lost, shared, or hoarded.

Faculty members fear the theft of their research ideas. Advances in technology make shared research ideas vulnerable to capture and unethical reproduction. When job security depends on the demonstration of originality and vision, there is little or no incentive for those with knowledge insights to share with those who are struggling.

CONCLUSIONS AND FUTURE RESEARCH

Having gained insight into the study of KM, we hope to extend this survey by proposing a reward structure in colleges and universities that would make knowledge sharing an enhancement to promotion policies and job security. As was stated by Novins (2002), "The solution isn't creating the world's greatest database repository of all wisdom with the world's fanciest search engine. Instead, we need to give people specific tools designed to help them do their job and solve specific business problems." Hopefully, those in higher education will be enlightened to see that they possess the tools to create a win-win situation in their institutions.

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A BUSINESS-LEVEL STOPPING CRITERION FOR AN UPSTART CLASSIFIER

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ABSTRACT

Classification-identifying the appropriate group to which an object belongs-is a process that is important to many aspects of business. Upstart is a mechanism that constructs a computer-based classification scheme by modeling the patterns that exist in a data set that has been separated into groups beforehand. The model that Upstart generates is structured as a network of nodes, which each serve as a linear separator for the data set. This network is composed of a single root node that is responsible for the entire data set and a number of child nodes which each serve to correct the mistakes made by the network within a specific subset of the data. Construction of an Upstart network will continue until some appropriate stopping criterion is met. In this paper, we introduce a novel stopping criterion based on the calculation of a breakeven point. This breakeven point stopping criterion will ensure that Upstart continues to build a more and more precise model of the data set until the benefits associated with the classification scheme sufficiently outweigh the costs associated with the classification scheme.

INTRODUCTION

Classification is the process by which a set of objects is separated into subsets based on their characteristics. Distinguishing which objects belong in which subset is the function of a classifier. Humans have long applied classification to nearly all areas of life-even very young children easily separate people into the subsets of immediate-family and others. "All sciences start with the process of selection or classification. The universe is too vast and complex to be treated as a whole; so a manageable part of it must be chosen for observation and investigation. Furthermore, all scientific laws are based on classification" (Wilson, 1952).

Classification is also of vital interest to businesses. Understanding business problems is the first step to developing rigorous and robust solutions to these problems, and appropriately classifying a business problem can play a key role in developing such a solution. Literature abounds with articles that propose frameworks for classifying problems encountered by managers. Walsh proposes a classification of business problems (Walsh, 1988). Melcher, Khouja, and Booth describe a classification system as "a system of nested hierarchical categories used to efficiently store, order, and analyze information about the entities being classified" (Melcher, Khouja & Booth 2002). If managers can effectively classify the problem being faced or classify the components of a large

problem into smaller subsets, then they may be well on their way to solving the problem appropriately.

UPSTART

In this paper, we describe an advanced version of Upstart-a technique that constructs a computer-based classifier (Freaan, 1990; Fanguy and Kubat, 2002). Upstart represents a classification scheme that is useful for separating a set of objects into appropriate groups, where each group represents a class of objects to which some concept applies. Once an Upstart classifier has been constructed, it may be used to identify which group is appropriate for a new and previously unseen object. This information will aid businesses in making decisions about the object.

Before an Upstart classifier may be built, a set of data must be prepared to train or build the classifier. Each element of the data set consists of two components: a list of values describing an object and a concept label that identifies the group to which the object belongs. Upstart will construct a classifier that models the patterns that are useful for distinguishing between the different groups of objects in this data set. For the purposes of this paper, we assume that the concept labels are either "positive" or "negative." That is, we group objects into two groups for a given concept-either the concept holds (positive) or it does not (negative).

For example, one may be interested in separating loan applicants based on the concept "good credit risk." We first gather a set of data describing previous applicants that we can label as positive or negative-positive for the "good credit risk" applicants and negative for the "bad credit risk" applicants. We can use this data set to create an Upstart classifier that will model the patterns necessary for distinguishing between the two groups of applicants. Once constructed, the classifier may be used to predict whether a new applicant will be a "good credit risk" or a "bad credit risk" by applying the patterns that are identified in the data set used to construct the classifier.

An important issue that must be dealt with when building a classifier is deciding when to stop construction. While we may be tempted to stop only when the classifier perfectly models a data set, this may not be feasible or desirable. In this paper, we propose a novel stopping criterion that focuses on whether it makes economic sense to continue classifier construction.

In the next sections of this paper, we briefly examine how the Upstart algorithm constructs a classifier and consider Upstart from a business perspective. Subsequently, we present a novel stopping condition based upon calculating a breakeven point. In the final section, we conclude by summarizing our contribution.

CONSTRUCTING AN UPSTART CLASSIFIER

Upstart begins the construction of a classifier by creating a root node which serves to separate the elements of the data set into two groups using a linear equation. Depending on which side of the linear equation an example falls, it is classified as either positive or negative. However, only a select group of data sets will be modeled appropriately by a single linear equation. Therefore, Upstart adds nodes to the network to correct the two types of mistakes that may occur at the root node-incorrect positive errors and incorrect negative errors. One node serves to better model the examples labeled as positive at the root node by finding a linear equation to separate correct positive

examples (positive examples classified as positive) from incorrect positive examples (negative examples classified as positive). A second node serves to perform the same function for examples classified as negative-distinguishing between correct negative examples (negative examples classified as negative) and incorrect negative examples (positive examples classified as negative). These new nodes may also make mistakes; therefore, Upstart applies the same corrective action-it adds more nodes to the network to focus on these errors. Upstart constructs a classifier by continuing this process of adding nodes to correct classification errors.

UPSTART FROM A BUSINESS PERSPECTIVE

In considering Upstart, we now present an example drawn from business-predicting credit risk. Let us assume that we are interested in distinguishing between banking customers that are good credit risks (positive examples) and bad credit risks (negative examples). The implications of a specific classification scheme in this context are as follows. If each of the customers labeled by the Upstart network as positive (a good credit risk) is actually positive, then the loan officer will be assured that the customers who are labeled as positive will pay their loan. However, since almost no classification scheme is 100% accurate, there will normally be some customers who are labeled as positive that are actually not good credit risks-these examples are incorrect positives. Each incorrect positive is a customer who defaults on a loan. This translates into loss of interest on the loan-and perhaps even principal. It also translates into repossession/foreclosure costs and the loss of potentially giving the loan to a good customer. If each of the customers labeled by the Upstart network as negative (a bad credit risk) is actually negative, then the loan officer will be assured that the customers who are labeled as negative would not pay back their loan. However, there are likely to be some customers who are labeled as negative that are actually good credit risks-these examples are incorrect negatives. This translates into a lost business opportunity-a good customer that is incorrectly turned away. This customer will likely go to my competitor to get their loan.

EXISTING STOPPING CRITERIA

Although we always want an accurate classifier, it is not always possible or desirable to build a perfect classifier. Careful consideration must be given to the point at which the construction of a model of the data set should be halted. It is common for algorithms that build classifiers to stop when classification accuracy meets some predefined level. Another stopping criterion that may be borrowed from decision tree constructors (Quinlan, 1993) is to stop if the number of examples being handled by a consultant is too few. As we go deeper in the Upstart network, the portion of the dataset handled by each node gets smaller and smaller. When the size of the data set reaches some minimum threshold, then we can stop construction of that branch of the network.

Stopping criteria are often used to deal with the presence of noise-in the form of incorrect property values or incorrect concept labels-in the data set. When noisy data is used to construct a classifier, we do not wish our classifier to perfectly model the data. We are interested in the general patterns that exist in the population from which the data set was drawn-not the particular patterns in the data set itself. When applying Upstart to noisy data sets, we must use some set of criteria that allows the algorithm to stop without requiring a perfect modeling of the data. While a thorough

discussion of stopping criteria designed to prevent this problem within the context of Upstart is outside the scope of this paper, the interested reader is directed to (Fanguy, 2001).

BREAKEVEN POINT AS A STOPPING CRITERION

As Upstart continues to grow a network of nodes, the classifier will more closely approximate the data set. The stopping criteria used to halt Upstart should ensure that construction continues until the classifier models the patterns in the data set appropriately. Different stopping criteria will ensure that this goal is met in different ways. From a business perspective, we could consider the problem of deciding when to stop building an Upstart classifier by determining whether or not it is economically beneficial to do so-based on the costs and benefits associated with adding consultant nodes to the network.

Such a stopping criterion will ensure that Upstart network construction continues until the benefits of the patterns modeled by the classifier outweigh the costs of those patterns by a given threshold. In order to do this, we must be able to measure benefits and costs. We propose computing them as functions of the variables we can calculate during network construction:

- * N_p : the number of examples classified as positive,
- * N_n : the number of examples classified as negative,
- * N_{fp} : the number of examples incorrectly classified as positive, and
- * N_{fn} : the number of examples incorrectly classified as negative.

The decisions that are made will be based on the classifier's output of either positive or negative. Therefore, the number of positively-labeled examples (N_p) and the number of negatively-labeled examples (N_n) will determine the benefit obtained by the classifier. In general, we can express the benefit as a function $B()$ of the number of positively- and negatively-labeled examples- $B(N_p, N_n)$. The benefit is reduced by the costs associated with mislabeled examples-incorrect positives and incorrect negatives. In general, the costs may be expressed as some function $C()$ of the number of incorrect positives (N_{fp}), and incorrect negatives (N_{fn})- $C(N_{fp}, N_{fn})$. Now that we have a representation for the costs and benefits of the classifier, we can express our stopping criterion in terms of these functions as:

$$B(N_p, N_n) - C(N_{fp}, N_{fn}) \geq P,$$

where P is the threshold above the break even point that we must achieve- P represents the margin of profit that we must achieve based on some business objective. In order for the stopping criterion to be useful, P is subject to the constraint that it must be less than or equal to the maximum benefit-minus-cost calculation possible. This calculation will be maximized when all examples are correctly classified.

As a simple example, we can consider the loan example that has been explained. In this example, the decision concerns whether or not a loan offer should be extended to an individual. For the sake of simplicity, we can say that we expect an average benefit of $\$X$ from each loan approved

(positively-labeled example). Since no loan will be given to those examples labeled as negative, we will receive no benefit from the negatively labeled examples. Therefore,

$$B(N_p, N_n) = N_p * \$X$$

The costs in this example are associated with incorrect positives (those who we gave loans to that were bad credit risks) and incorrect negatives (those who we did not give loans to that were good credit risks). For our current example, we can say that each incorrect positive costs us an average of \$Y and each incorrect negative costs us an average of \$Z. Therefore,

$$C(N_{fp}, N_{fn}) = N_{fp} * \$Y + N_{fn} * \$Z$$

Note that B() and C() may be arbitrarily complex functions. With these functions defined, we can apply the Upstart algorithm to construct a classifier. Upstart will proceed until the condition $B(N_p, N_n) - C(N_{fp}, N_{fn}) \geq P$ is met. With this stopping criterion in place, we can be sure that Upstart will continue until it is economically beneficial to halt construction.

CONCLUSION

In this paper, we introduce Upstart as a process that constructs a network of nodes that serve as a classifier, which assigns an object to a group by generating a concept label for the object. Such a model will be helpful in a business context in that it will aid in making informed decisions concerning the objects being assigned to groups.

The major contribution of this paper is the introduction of a new criterion that may be used to determine when Upstart should halt classifier construction. This new criterion ensures that Upstart will continue to build a more precise classifier until the benefits of the classification scheme sufficiently outweigh the costs associated with the classification scheme. Thus, we can ensure that the classifier is sufficiently accurate from a business perspective.

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THE MIS ACADEMIC AREA: THE STATE OF THE PROFESSION

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ABSTRACT

The MIS area has been subject to swings in supply and demand, both in terms of faculty and students. Existing research has suggested that a shortage of MIS faculty members could negatively impact the quality of teaching, research, and service in the MIS area. This paper evaluates the current state of the profession utilizing factors drawn from past research efforts. Surveys of IS faculty members at AACSB institutions indicate salary compression and budget concerns do cause difficulties, although doctoral or private institutions appear to have fewer problems than do masters level or public institutions. Respondents felt they had greater service and teaching commitments, and less time available for research. These effects were magnified at masters level institutions. But, respondents also agreed that both MIS research productivity, quality of instruction, and overall faculty quality had improved over the past five years.

INTRODUCTION

The management information systems (MIS) area has been a very dynamic one over the past few years. At the turn of the century, researchers (Freeman et al, 2000) issued very negative forecasts regarding supply and demand for MIS faculty members. These researchers were concerned that a growing shortage of faculty members, combined with ever increasing enrollments, would have negative effects on the profession. However, the situation may have changed recently. Anecdotally, the demand for faculty members appears to have lessened, and enrollments seem to be down at many universities. This research attempts to evaluate the current state of the profession by surveying the professoriate utilizing factors drawn from existing research.

SUPPLY AND DEMAND ISSUES

Although the market seems to be returning to normal, the recent faculty shortage was not unexpected. Faculty shortages have been predicted and reported in engineering, mathematics, business, computer science, the health professions, and MIS (Altbach and Lewis, 1992; Freeman et al, 2000; "Short Faculties", 1990). Several factors have been blamed for this shortage.

Retirement may lead to a change in the availability of faculty members. Some research suggests that the number of faculty retirements remains somewhat constant over the years ("Shortage of Professors Predicted", 1992); however, Edelson (1992) notes that "the majority of full-time college faculty members will be aged 60 or older in 2000." In addition, other research suggests that a significant percentage of faculty members eligible to retire are doing so (Stein and Trachtenberg, 1993).

A declining number of new Ph.D.s may also contribute. Since the 1970's and early 1980's, there has been a drop in the number of doctoral candidates in general ("Short Faculties", 1990) and specifically in the MIS field (Freeman et al, 2000). Further, a higher proportion of the doctorates granted in this country are to foreign students who often return home after completing their degrees (Edelson, 1992). Also, many individuals are taking longer to complete their doctorates (Altbach and Lewis, 1992; Edelson, 1992) or elect to enter industry rather than academia (Edelson, 1992).

Fluctuations in enrollment also contribute to changes in demand for IS faculty members. A few years ago, enrollment in MIS courses increased drastically (Freeman et al, 2000). More recently, enrollment appears to be declining.

Salary compression may also cause fluctuation in the demand for MIS faculty members. The salary rate for new MIS doctoral hires tends to reflect supply and demand ratios in the marketplace. Recent self-reported salary figures (IS World Faculty Salary Survey) reflect an escalating salary rate. Declining support caused by state budget issues also contributes to salary compression in many universities. This lack of funding results in smaller salary increases and may leave faculty thousands of dollars behind market value after several years. For 2002, 65.3% of states report a bleak budget outlook (Hebel et al., 2002). Such a situation can lead to both increased turnover and a decrease in morale (Altbach and Lewis, 1992; Bowen and Schuster, 1985; 1986).

EFFECTS ON THE WORK ENVIRONMENT

Fluctuation in the availability and demand for MIS faculty members may have significant impacts upon the profession. A number of potential impacts are discussed below.

Fluctuation in the ratio of faculty to students may lead to increasing faculty teaching loads, especially when the number of faculty decreases and the number of students increases (Whitman et al., 1999). Faculty members may be asked to either teach more or larger sections, which may lead to reduced quality of instruction and to reduced research productivity. Although the popular press often suggests that the quality of instruction falls as class size increases, research regarding this relationship is somewhat mixed. Esinoza et al (2000) note that high school counselors consider class size to be an indicator of university quality and thus recommend universities with smaller class size. Other research suggests that class size is unimportant (Clark et al, 1975; Hatch, 1961; Marsh, 1978; Overall, 1977; Williams, 1985), although class size is related, at least to some degree, to teaching evaluations or perceptions of quality (Fernandez, 1998; Mateo, 1996). However, Gilbert (1995) notes that personal contact between faculty members and their students can generate a significant difference in learning outcomes. Cramer and Alexitch (2000) also indicate that class size and personal contact outside the classroom influence faculty sensitivity to student needs. As faculty members teach more and larger courses, the time available to spend helping individual students naturally decreases. This may result in a lower overall quality of instruction.

Fluctuations in the supply of faculty members may also result affect research productivity. Whitman et al (1999) note that pressure to publish is increasing in both teaching- and research-oriented universities. Since time is a limited resource, faculty members facing increased teaching loads may be unable to spend as much time on productive research. This places the individual faculty member at risk (Freeman et al, 2000). Thus, faculty members may be unable to achieve tenure or may elect to move to a university that provides more time for research.

An increased service load may also result from a lack of faculty members. Whitman et al (1999) also note that IS faculty members are facing increasing service loads. This increasing service load has essentially the same impact as increased teaching loads; namely, a decrease in the time available for productive research. Again, this places the individual faculty member at risk and may result in faculty moving to other universities.

Morale can also be affected by fluctuations in the supply of faculty. Faculty in the MIS area are already facing high levels of work-related stress (Whitman et al. 1999) which can cause job burnout (Kanner et al., 1978; Pines et al., 1981), resulting in higher turnover and turnover intentions (Moore, 2000). Increasing workloads coupled with salary compression further aggravate this issue.

Universities may modify the number of lecturers they employ as faculty supply fluctuates. While most lecturers do an excellent job, the resulting decrease in Ph.D. coverage is concerning since it may threaten AACSB accreditation.

A shortage of faculty members also makes recruiting more difficult. Since recruiting at the university level is a time consuming process, much time may be devoted to recruiting rather than to other productive activities. Given the number of positions available on the AIS/ICIS and DSI placement sites when the demand for IS faculty members was at its highest, such activity can consume a large amount of time.

Course availability may also be threatened when faculty members are in short supply. Although most undergraduate students assume that they can complete their degrees in four years, this may no longer be true. A fluctuation in the faculty to student ratio may result in a lack of course availability. Departments may simply be unable to meet the demand for MIS courses, or may be unable to teach major courses each semester. Either way, some students may be unable to graduate within the normal four-year time span.

METHODOLOGY

A questionnaire was developed to investigate the attitudes of IS faculty regarding the state of the profession. The questionnaire has four sections: demographics, attitudes regarding faculty supply and demand issues, attitudes regarding work environment, and attitudes regarding the state of MIS Ph.D. programs. The demographics section requests the following information: the Carnegie classification of the university, whether it is public or private, the academic rank of the respondent, the years of academic experience, gender, age, ethnic background, U.S. native, total enrollment of the institution, and the enrollment of the college or school.

The supply and demand attitudinal portion of the questionnaire consisted of 13 items focused on three major areas: enrollment, compensation and budgets, and the state of the MIS personnel market. Items were scored on a seven point Lickert scale with one indicating strong disagreement and seven indicating strong agreement. The work environment section consisted of 23 questions

that examined teaching, research, service, recruiting, and faculty strength. Finally, for those faculty teaching at schools with an MIS doctoral program, the last section examined perceptions of doctoral student quality, quantity, and demographics.

The questionnaire was pilot tested using several potential members of the target population. After evaluation and modification, it was then administered via the Internet to Information Systems faculty members at all American Association of Collegiate Schools of Business (AACSB) accredited institutions. In all, 2400 emails were sent and a total of 244 useable responses were received. This yielded a response rate of approximately ten percent. The results were then analyzed using SPSS.

RESULTS

The respondents' institutions fall into the following categories: 21% Doctoral Extensive, 37% Doctoral Intensive, 28% Masters I, and 11% Masters II, and 3% other. Public institutions outnumbered private nearly eight to one. The mean university size was 17,500 and the average school/college size was 2600. The respondents were predominantly Caucasian (77%) males (75%) born in the U.S. (75%). Most (59%) were between the ages of 35 and 55, with an average experience level of 15.5 years. Respondents were equally distributed between assistant, associate, and full professor ranks.

SUPPLY AND DEMAND

Overall, the respondents strongly agreed that state budgets are a source of MIS staffing problems. They also agreed strongly with the idea that salary compression is a problem. On a related note, surveyed faculty slightly agreed with the notion that not enough MIS Ph.D.s were being produced, and that an MIS staffing problem would be with us for the next 5 years. Interestingly, neither enrollment growth nor losses due to retirement were seen as significant issues.

A comparison of means identified some interesting differences between public and private institutions. Salary compression, budgetary constraints, and enrollment are all perceived as significantly ($p < .05$) less of a problem at private institutions. In addition, faculty members at masters level institutions regarded retirement, salary compression, enrollment growth, and the number of new Ph.D.s being produced as significantly ($p < .05$) more severe issues than faculty at doctoral institutions. Finally, a comparison of U.S. vs. non-U.S. born respondents show that non-U.S. born faculty have a significantly ($p < .05$) more optimistic view of the faculty staffing issue.

Correlation analysis shows that business school size is significantly ($p < .05$) positively correlated with both the perception of the quality and quantity of MIS applicants. In short, faculty at larger business schools appear to have a more positive outlook than those at smaller business schools.

THE WORK ENVIRONMENT

Most respondents agreed slightly with the idea that the overall teaching and service load had increased. In addition, faculty also agreed that they had less time overall to perform research. But, respondents also agreed that both MIS research productivity, quality of instruction, and overall

faculty quality had improved over the past five years. In terms of recruiting, respondents also noted that recruitment had become more difficult and time consuming.

A number of statistically significant differences were detected between respondents, again primarily based upon type of institution. Respondents at masters level institutions reported significantly higher teaching loads, lower research productivity, lower overall faculty strength, and more difficulty recruiting. Statistically significant differences were also detected in class size and availability between public and private institutions. Private institutions appear to have significantly smaller classes and better course availability.

Correlation analysis reveals a number of interesting significant ($p < .05$) relationships. For example, respondent time at current institution is negatively correlated with perceptions of faculty strength, agreement that more preps are required, and agreement that more time is available for research. A respondent's length of employment at their current institution is also positively correlated with a belief that faculty quality is slipping. In short, faculty members with longer times of service at any given university tend to feel that faculty quality is declining, that fewer preps are required, and that less time is available for research. Further, the longer a faculty member remains at the same university, the less likely they are to consider leaving.

THE STATE OF DOCTORAL EDUCATION

Respondents from institutions with doctoral programs indicated that the quality of applicants for their Ph.D. programs has improved over the past five years. They also agreed slightly that economic conditions have had a positive impact on applications. The responses indicate, however, that proportion of foreign applicants has increased. Faculty agreed slightly that it has become more difficult to attract U.S. citizens. Finally, the responses indicate that it appears that the overall quantity of Ph.D.s produced should remain the same over the next five years.

CONCLUSION

This study examined faculty perceptions of the MIS academic profession in the following areas: attitudes regarding faculty supply and demand issues, attitudes regarding work environment, and attitudes regarding the state of MIS Ph.D. programs. The results indicate that state budgets, salary compression, and an undersupply of MIS Ph.D.s are all supplied related problems in this field. These problems were magnified at masters level and public institutions.

Respondents felt they had greater service and teaching commitments, and less time available for research. These effects were magnified at masters level institutions. But, respondents also agreed that both MIS research productivity, quality of instruction, and overall faculty quality had improved over the past five years.

Respondents from institutions with doctoral programs indicated that the overall quantity and quality of MIS Ph.D.s should remain the same over the next 5 years. However, there has been an increase in the percentage of non-U.S. citizens applying for graduate study.

The results of this study should be viewed in light of a number of limitations. First, the response rate was approximately 10 percent and the sample could have some self selection bias.

However the demographics tend to indicate a fairly accurate sample. Second, questionnaires always entail research tradeoffs. More research is needed to further explore the state of the MIS profession.

REFERENCES ARE AVAILABLE UPON REQUEST FROM BRYAN FOLTZ

THE VISUAL COMPUTER: EXPLORING THE INTERNAL WORKINGS OF A PC IN THREE DIMENSIONS

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ABSTRACT

Our university requires an introductory level course focusing on basic concepts, computer knowledge, and skills. Students often have difficulty understanding hardware concepts, especially the interaction of components. Rather than attempting to understand the interaction between components, many students simply memorize definitions, and never quite grasp how the parts interact. Visualization using computer animation is one possible solution to this dilemma. Research suggests that virtual reality (3D displays) may result in dramatic improvements over traditional learning methods. Animation and visualization have been applied to various academic areas. This paper details the development and use of a visualization tool used to study information systems, specifically, the interaction of components within the computer. The paper also reports the results of a study of classes taught with and without the Visual Computer. Finally, a brief discussion of experiences gained and suggestions for future research efforts are presented.

INTRODUCTION

Our university, like many others, teaches an introductory level course focusing on basic concepts, computer knowledge, and skills. Although the students seem to enjoy hands-on activities using different software packages, many struggle with concepts and basic computer knowledge. Students have difficulty understanding hardware concepts, especially the interaction of components. Rather than attempting to understand the interaction between components, many students simply memorize definitions. Some faculty members bring hardware collections to class so that students can touch and feel the pieces, but many students simply associate a name and function with the various components and still do not understand how the parts interact. Perhaps this difficulty should not be surprising; after all, one cannot see the electrical impulses moving between components, nor the data flowing from the diskette to the hard drive! A similar problem has been reported in the sciences, where students experience difficulty viewing the interaction of numerous pieces of information as an overall framework (Brandt, et al, 2001).

VISUALIZATION: A POSSIBLE SOLUTION

Visualization using computer animation is one possible solution to this dilemma. Existing research suggests that many educators, researchers, and trainers believe that virtual reality (3D displays) will result in dramatic improvements over traditional learning methods (Inoue, 1999). Further, other researchers have already examined the impact of static visualization and animation on learning (Lim, 2001; Wilson and Dwyer, 2001). In chemistry, one study showed that an instructor-led animation presentation helped students understand chemical relationships (Yang, et al, 2003). Animation and visualization have also been used to teach astronomy and planetary sciences (Yair, et al, 2003). However, no research focusing on visualization as a learning tool in information systems has been found. This is somewhat ironic considering that computer technology forms the basis for most visualization tools.

This paper details the development and use of a visualization tool designed to help students understand the interaction of components within the computer. This visualization, dubbed the Visual Computer, was used for two semesters. This paper also reports the results of a study of classes taught with and without the Visual Computer. Finally, a brief discussion of experiences gained and suggestions for future research efforts are presented.

THE VISUAL COMPUTER

Initially, the Visual Computer was conceived of as a photorealistic representation of the internal workings of a computer. The general objective included depicting the major components of the PC as well as the transfer of data between those components. Other planned enhancements included a close-up capability to show the detailed workings of a PC, along with a visual representation of a small network. However, these goals were set without consideration of the available hardware and software.

HARDWARE AND SOFTWARE SELECTION

A Reconfigurable Advanced Visualization Environment (RAVE) 3D display unit from Fakespace Systems Inc. was available at our university. In addition, training and support in the use of this device were available. Two different software packages, 3D Studio Viz and AVS, were available for faculty use. 3D Studio Viz is a graphical drawing package, while AVS is a data visualization package. Initially, the drawing capabilities of 3D Studio Viz seemed advantageous. However, AVS was recommended since it supports animation and is more easily transferred to the RAVE. Thus, AVS was selected. After completing a two-day training program, full-scale development of the Visual Computer began.

CREATING THE VISUAL COMPUTER

AVS reads a data file and displays that data graphically. The user creates a program to control how data is modeled within a 3D cube. Shapes are represented by defining coordinates within this 3D space and indicating which points are connected with lines. Animation is created by

establishing a shape and specifying the beginning and ending coordinates of the straight path it is to follow. In this manner, AVS was used to create a rough representation of a computer's interior.

The Visual Computer illustrates the motherboard, CPU, memory chips, bus, hard drive, floppy drive, speakers, printer, keyboard, and mouse. Data can be seen moving through the system. However, the components are not photorealistic as originally planned; rather, simple line drawings and figures are used. During development of the VC, two unexpected issues arose. First, AVS is more complex than expected. Despite excellent technical support, developing the VC consumed most of a summer. The decision to use line drawings rather than photorealistic images was based primarily upon the unexpectedly steep learning curve associated with the software. Second, AVS is not widely distributed on campus. This lack of availability limited testing until the VC was installed on the RAVE itself.

USING THE VISUAL COMPUTER-AN INITIAL ATTEMPT

The VC was developed during the summer session and used the following fall and spring by two instructors in eight classes. Four classes (two for each instructor) were held as controls and were not exposed to the Visual Computer. The remaining classes (the experimental group) were taken to the RAVE facility for a demonstration of the Visual Computer. Following a brief demonstration provided by a trained operator, the students were able to view the VC while their instructor discussed the internal workings of a PC. Since each class enrollment exceeded the number of available goggles, the students were required to share. This did not seem to present a problem. However, access to the RAVE is strictly controlled and somewhat limited. Each class was able to visit the RAVE only once due to scheduling conflicts, and students are not permitted into the facility alone without prior approval. To examine the exposure's impact, instructors added questions to the exams in all four classes.

Results

Table 1 summarizes the questions and correct student responses from classes that were and were not exposed to the VC. Initial inspection suggests that the VC had limited impact upon learning, as only a few statistically significant differences were detected using a test of proportions. However, the instructors reported that students were impressed with the technology and were more curious about the PC's internal workings. Although the initial results are disappointing, a number of factors must be considered.

ISSUES AND LIMITATIONS

There are several possible explanations of why no significant differences in treatments occurred. The first possibility is that visualization may be poorly suited to helping students understand the PC's internal workings. Although existing literature from other disciplines suggests visualization should help students learn, no similar IS projects have been found. Perhaps students in this introductory level course are simply not prepared to focus on the interactions between

components. If the students do not understand the functions of the components, understanding the interaction between components may be much more difficult.

The design of the VC may be incompatible with the instructor's teaching methodology. The VC is designed for guided interactive use. The instructor 'flies' the students through the PC's internal workings and explains how components work together. All classes in this experiment were taught by two instructors with minimal involvement of the VC developer. Instructor style could cause unexpected results. For example, time spent on and emphasis of the importance of the demonstrations may have varied.

The RAVE is not freely available to classes or individual students. Increasing demand makes classroom access to the RAVE more difficult. Also, students cannot use the RAVE individually. As a result, participating students were only exposed to the VC once. This single exposure, and the lack of hands-on experience, could lessen the effectiveness of the technology.

The questions selected to evaluate the benefits of the VC may be inadequate. To minimize the extent of interference with classes, the instructors who initially agreed to use the VC were asked to select questions regarding the PC's internal workings. Only six questions were added to the exam that related to the VC use. As noted in Table 1, student scores, regardless of treatment, were consistently high on all questions. Perhaps the questions were not sufficiently difficult to differentiate between different knowledge levels.

Question	Correct Responses		Correct Responses	
	(Instructor One)		(Instructor Two)	
	Exposure	No Exposure	Exposure	No Exposure
Diskettes provide a form of _____ storage (a) temporary (b) permanent (c) secure (d) expensive	53%	64%	75%	85%
Electronic interfaces through which devices like the keyboard, monitor, mouse, and printer are connected to the computer are called (a) docks (b) ports (c) peripheral replicators (d) passages	95%	93%	87%	97%
The bus is _____ (a) a collection of wires through which data is transmitted from one part of a computer to another (b) a mass transit vehicle (c) an internet system for moving large amounts of data (d) a collection of wires used to move data from one computer to another	95%	89%	79%	75%
_____ is an opening in a computer where a circuit board can be inserted to add new capabilities to the computer. (a) expansion board (b) expansion slot (c) expansion card (d) expansion opening	98%	100%	70%**	55%**

Table 1: Performance on Exam after Exposure to the Visual Computer				
Question	Correct Responses		Correct Responses	
	(Instructor One)		(Instructor Two)	
	Exposure	No Exposure	Exposure	No Exposure
Diskettes provide a form of _____ storage (a) temporary (b) permanent (c) secure (d) expensive	53%	64%	75%	85%
The main circuit board in a micro computer system that handles I/O signals from peripheral devices and has memory chips is known as the (a) parallel device driver (b) sisterboard (c) fatherboard (d) motherboard.	100%**	96%**	94%	92%
A port is an interface on a computer to which you can connect a device. Many computers sold today include a port that transmits eight bits at one time. This is called a _____ port, as opposed to a _____ port, which only transmits one bit at a time. (a) SCSI, USB (b) parallel, serial (c) serial, parallel (d) USB, parallel	98%*	84%*	79%	77%
Number of Students Taking Exam	58	55	53	60
* significant at the .05 level for a one-tailed test of proportions				
** significant at the .10 level for a one-tailed test of proportions				

CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH

Although the results are somewhat disappointing, the process of developing and testing the Visual Computer provide a number of avenues for future research. First, this initial foray into the use of visualization to demonstrate computer concepts was brief and simplistic. It comprised only a small portion of the total concepts covered in the class and was not as multi-dimensional as the developer would have liked. More study is needed of visualization tools that can be used in the classroom and by individual students on an ad-hoc basis.

Faculty members considering the development of a visualization project must carefully consider costs and benefits. Development of the VC was considerably more difficult than anticipated. Lack of experience complicated the software selection procedure and actual coding of the project. In addition, the learning curve for AVS was steep. Despite good technical support, the project still consumed most of a summer. To date, no significant benefits have materialized directly from the VC.

Limited exposure limits the benefit of visualization projects. Before developing a visualization project, faculty members should consider the availability of RAVE facilities. The popularity of the RAVE at ECU complicates class scheduling. Further, students are not permitted to use the facility without supervision. These constraints limit student exposure to the VC, thus limiting potential benefits.

Despite the difficulties encountered in this project, visualization has promise in the educational field. However, faculty members must carefully consider whether the effort required to create and utilize visualization projects is worthwhile.

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THE METHODOLOGY USED TO CALCULATE ECONOMIES OF SCALE FOR MISSISSIPPI LANDFILL OPERATIONS

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ABSTRACT

This paper provides the methodology necessary to calculate the existence of economies of scale for Mississippi landfill operations that meet the requirements for sanitary landfills. A test was used to determine if economies of scale exist under present operating standards for current landfill operations. Economies of scale proved to be a significant factor in determining the feasibility of applying the sanitary landfill technology.

INTRODUCTION

The sanitary landfill is an excellent technology for Mississippi. The sanitary landfill, when compared with alternative technologies, offers Mississippi the most economical method of efficiently disposing of existing solid waste accumulations. The capitalization required to establish a sanitary landfill is minimal when compared to alternative technologies. Haul cost is not yet a prohibitive factor in Mississippi because no municipality presents what can be termed an urban sprawl. The land space available for solid waste disposal activities is not prohibitive in cost, and the prospect of returning land of higher value at the completion of landfill operations is an added benefit.

PERSONNEL COSTS

A survey of existing literature failed to provide a guide for the compensation of landfill personnel. Interviews with several consulting engineers associated with the Mississippi State Board of Health revealed that the only regulator of wages for landfill personnel is the federally established minimum wage. Wages and salaries vary upward from the base minimum wages depending on the individual municipality and the position to be compensated. Labor cost for a given function probably varies from landfill to landfill. An unpublished study completed by Cook, Cugin, Kelly, and Cook, consulting engineers located in Tupelo, Mississippi, was used as a guide for this research.

There were essentially three reasons for reliance on the cost estimates provided by the preceding study. First, there was a lack of relevant cost data provided in the existing literature. Second, this study was the only one of its kind in Mississippi at the time this research was conducted. Third, the cost estimates were based upon wage scales and input prices that prevailed in Mississippi.

The main elements of cost directly concerned with the day-to-day operation of the landfill were composed of the landfill supervisor's wage and the wage of the equipment operators. A Lee County study established the annual wage for the landfill supervisor at approximately \$7,200. In 1970, this same study set the wage of a heavy equipment operator at about \$6,000 annually (Cook, Kelly, Cugin & Cook, 1970). Note should be made, however, that although the equipment operator was engaged in equipment operation only a minimal part of the working day, he still received a competitive wage. Most likely, equipment will be operated coincidentally with the arrival of the refuse trucks. According to Douglas Chin, consulting engineer, Mississippi State Board of Health, the maximum time that equipment will remain in operation is approximately four hours daily. The remainder of the time the equipment operator will spend controlling litter, servicing the equipment, and aiding the landfill supervisor. The equipment operator must be paid a competitive wage in order to assure his employment--he is guaranteed a forty-hour week. In 1971, construction equipment operators in Mississippi received \$2.75 to \$3.00 per hour; however, these construction operators worked only seven or eight months per year. Landfill operators receive on the average \$2.75 per hour, but these operators have the advantage of year-round employment (Personal conversation with Bob Beasley, a sales representative of Stribling Brothers Heavy Equipment Sales, Jackson, Mississippi, November 26, 1971).

SANITARY LANDFILL COSTS

The major expense in the initial investment of the sanitary landfill is the cost of the site itself. Land values are extremely variable, depending on the value of the surrounding land. In 1965, landfill sites were purchased in the Los Angeles metropolitan area for prices ranging from \$2,000 to \$20,000 (American Public Works Association, 1970). Although the price of the landfill is a major factor in landfill site selection, the price alone should not render a potentially successful technology prohibitive. First, the cost per acre of a landfill is affected by the depth of the landfill. Consider an acre of land purchased for \$10,000. If the landfill is filled to a depth of 10 feet, then the land costs 62 cents per cubic yard filled. If the average depth can be increased to approximately 100 feet, then the cost is only six cents per cubic yard filled (American Public Works Association, 1970).

Secondly, the land use of a sanitary landfill is augmentative rather than consumptive in nature. Augmentative land use enables the municipality to discount the cost of land acquisition since the land's final value will be greater when the landfill operation is completed. Landfill acquisition costs should be considered a function of the value of surrounding land rather than the landfill operation itself. Other items considered in the initial investment are fences, roads, landscaping, and so forth. These items require little or no maintenance and are therefore considered part of the initial construction cost of the landfill.

SOLID WASTE COLLECTION

The Mississippi State Board of Health has no police power over municipal refuse disposal. In the early 1970s, the only state agency with any enforcement power was the Air and Water Pollution Control Commission, and the extent of these powers when dealing with solid waste was unknown.

Regardless of the type of technology used for the disposal of solid waste accumulations, the function of collection and possible storage of waste accumulations is essential. The cost of solid waste removal is the largest single expenditure in the solid waste disposal operation. In 1970, solid waste removal annually cost federal, state, and local governments about \$4.5 billion (A Systems Approach to the Problems of Solid Waste Disposal, 1970). In 1970, the collection of litter alone was estimated to cost about \$500 million yearly (A Systems Approach to the Problems of Solid Waste Disposal, 1970). Wages and salaries for collection manpower accounted for approximately 60 to 80 percent of total solid waste disposal costs in the U.S. annually (A Systems Approach to the Problems of Solid Waste Disposal, 1970).

This study was concerned with the costs of collection only to the extent that these costs affect the methodology of solid waste disposal. The problem of the differing techniques of collecting solid waste to achieve economies of scale in the collection function itself is a topic for further studies. One such study was performed by Ralph Stone and Company Inc., comparing one-man with multi-man crews. The cost analysis of any acceptable methodology of solid waste disposal should include the cost of the collection truck and the wages and salaries paid to the collection men. Also, the relevant costs of maintenance and subsidiary equipment will influence the total cost of refuse disposal systems.

TEST FOR ECONOMIES OF SCALE

Two possible explanations are offered to explain the lack of economies of scale--if they do not exist--for Mississippi landfill technology. First, economies of scale do not exist for landfill technology because of the many variable factors influencing cost for solid waste disposal. Secondly, economies of scale cannot be determined for operations of such small scale as the current landfill operations in Mississippi.

Although the average cost per ton is relatively high for operations of less than approximately 50,000 tons, economies of scale do exist as defined previously (decreasing cost per ton as scale increases). The width of the curve is representative of the fact that disposal cost varies from operation to operation since standardization of geographical terrain and working conditions is practically impossible.

The data obtained for Mississippi in this study proved to be of questionable reliability. The disposal budgets reported by the survey were concerned only with labor cost and equipment maintenance cost. These costs were estimates made for capital consumption, primarily because cities make no provision for depreciation. All capital equipment had to be amortized over the manufacturer's recommended life expectancy for heavy equipment. Since all of the 15 cities chosen for the sample used crawler tractors weighing in excess of 50,000 pounds, the amount added to the disposal budgets per piece of equipment was the same. The amortization period was established at

eight years. None of the landfills used in the sample had any permanent structures located on the landfill site.

Fifteen cities were chosen for the sample based on their classification of solid waste disposal operations. Those landfills that received an "A" classification were automatically included in the test data. Additional landfills were supplied from those "B" classification landfills that most nearly resembled an "A" classification. Usually these landfills maintained only minor nuisance factors that could easily be eliminated. Although the non-linear data, when plotted, definitely indicated what appeared to be the existence of economies of scale, the data were converted into logarithms to utilize the least squares equation to so that a simple regression analysis could be used to estimate the relationship between the average per ton cost of refuse disposal and the scale of the disposal operations. The city of Jackson was eliminated from the sample because of the large discrepancy between the tonnage input of Jackson and the city that generated the next highest tonnage per year. The difference between the quantity of refuse generated yearly in Jackson and Biloxi, which produced the second largest yearly tonnage, was 142,500 tons. The elimination of Jackson temporarily from the sample does not diminish the significance of the existence of economies of scale that is estimated by the least squares equation, but rather it enables a better fit to be achieved for the trend line through the plotted data. Using the least squares regression analysis, the following equation was obtained:

$$\text{Log}_y = 6.8441 - 1.6051 \log_x$$

Computation of the standard error of the regression coefficient and a test of significance of the empirical coefficient (slope) proved that there was a 98 percent degree of certainty that a linear relationship existed between the average cost per ton and the scale of operation. The negatively sloped linear function indicates that economies of scale exist for current landfill operations in Mississippi. Therefore, the hypothesis that economies of scale cannot be determined for small operations is rejected.

The existence of economies of scale in solid waste disposal operations in Mississippi is significant if present operations are to be converted to landfill operations that are aesthetically acceptable, or if new landfill operations are to be used to replace existing dumps. Equally significant is the fact that 60 percent of the average disposal cost per ton of the municipalities tested are equal to or below the national average cost per ton for solid waste disposal by the sanitary landfill technology. The national average per ton disposal cost ranges from \$.80 to \$1.50 (Technical-economic study of solid waste disposal needs and practices, 1969).

The sanitary landfill is possibly the most desirable technology available for Mississippi refuse disposal. Incineration was the only alternative available in the early 1970s for solid waste disposal. The large capitalization cost associated with incineration appears to make per ton costs prohibitive for small communities. Municipalities that elect the incineration technology in preference to the sanitary landfill must expect operating costs to vary from \$6.00 to \$15.00 per ton (Personal correspondence with Ralph Stone, president of Ralph Stone and Company, consulting engineers, May 18, 1972). Usually, cities that utilize the incineration technology are typically large population concentrations, where land space suitable for landfill areas is difficult to obtain.

The problem of scarce land for landfill site selection exists in Mississippi, but it has not progressed to the point of disrupting the continuation of sanitary landfill use. The main problem in Mississippi is that land costs are increasing for municipalities. However, land costs are present in either incineration or landfill technology. Mississippi is a rather large geographical area, relative to its population. Mississippi's geographical area is 47,358 square miles and the resident population was only 2,216,912 in 1970 (1970 census of population, Mississippi advance report, 1971). The state, therefore, appears to have ample area to utilize the technology of landfill operations. The prohibitive hauling cost that renders the sanitary landfill uneconomical for some highly populated areas is insignificant in a state where the largest city contains fewer than 155,000 people (Personal interview with D.B. Chin, Mississippi State Board of Health, November, 1971),

The sanitary landfill offers Mississippi a satisfactory method of disposing of its solid waste accumulations at a relatively low cost. The existence of economies of scale in those landfills tested the availability of land for reclamation, and the small amount of equipment necessary for successful operation of a landfill should provide the incentive needed for those municipalities now operating inadequate dumps to explore the benefits provided by the sanitary landfill. Inefficient, unsanitary solid waste disposal must no longer be permissible. The sanitary landfill provides a low cost answer to the open dump.

CONCLUSION

The location of a sanitary landfill is the result of both social and economic factors. Although the sanitary landfill can be operated within close proximity to residential and commercial properties, the reaction of the citizenry often dictates the location of the landfill. Often the municipality, faced with few alternative choices as to site selection for the landfill operation, finds the land acquisition cost high. However, the cost of the landfill itself should be regarded in terms of the finished product, namely the value of the reclaimed land after the landfill operation is completed. Landfills can provide land for city expansion, parks, golf courses, and other civic improvements. The landfill technology should be considered as a means of utilizing land of low value and returning land that will have some use to the community.

The final element in the decision to adopt the sanitary landfill is that the operation must be economical for the present and the near future in order for municipalities to benefit fiscally from the adoption of a landfill technology. The Mississippi study yielded positive evidence that economies of scale can be calculated. Therefore, Mississippi would benefit from expanding and improving the refuse disposal operations currently in use rather than by attempting to implement a new and more expensive technology.

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SOCIAL PSYCHOLOGY FOR IT PROFESSIONALS: A PROPOSED MODEL

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ABSTRACT

This paper begins to lay the foundation for the development of a model of social psychology for information systems researchers and practitioners that promotes the accurate and meaningful assessment of end users IT skills; identifies the most effective ways to develop and enhance IT skills; helps promotes mutual understanding and reduces the technological, communication, and psychological "gaps" that often exist among the end users of information technology and the IS professionals who support them ; and provides a useful framework for interpreting past research and theory-based impetus for future research.

INTRODUCTION

End users of IT are increasingly dependent upon on ever-changing information technologies for personal and professional success. However, many end users have experienced incomplete or unsatisfactory IT training in the workplace, been befuddled by software applications with cryptic "help menus", become "lost" when installing or updating software applications, or have had difficulties with telecommunication technologies (Concord, 1999; MORI, 1999). End users typically turn to IT professionals (e.g., network administrators, help desk personnel, or software and hardware vendors) for IT training and for help resolving IT-related problems. In today's internetworked world, the personal and professional success of both end users and IT professionals is increasingly dependent upon on effective interpersonal interaction. Unfortunately, IT professional-end user interaction in many IS settings too often appears to result in mutual frustration and blame laying rather than effective training or problem solving behaviors (Concord, 1999; MORI, 1999).

A review of the research and popular literature reveals several potential causes of IT-related frustrations of the sort described above. Though IT professionals recognize the importance of personal and interpersonal factors in the successful adoption and use of IT, their primary focus is typically on the technology, rather than the end user. Moreover, prospective IT professionals seldom receive instruction in the behavioral issues associated with end user training and support (Karsten, 2002). An initial examination of the research literature suggests that one of the reasons for this lack of attention to the human side of the equation is the fragmented nature of the existing research into the personal and interpersonal factors affecting the acquisition and use of IT by end users, and successful IT professional-end user interaction.

Consequently, the purpose of this paper is to begin to lay the foundation for the development of a model of social psychology for information systems (IS) researchers and practitioners that (1)

promotes the accurate and meaningful assessment of end users IT skills (2) identifies the most effective ways to develop and enhance IT skills (e.g., the delivery of IT training) (3) helps promotes mutual understanding and reduces the technological, communication, and psychological "gaps" that often characterize problem-solving interactions among the end users of information technology and the IS professionals who support them (4) provides a useful framework for categorizing and interpreting past and present research on these topics, and also provides theory-based impetus for future research.

LITERATURE REVIEW

The proposed model will incorporate the tenets of Social Cognitive Theory (SCT) (Bandura, 1997) and Social Attribution Theory (Weiner, 1985; Kelley, 1973), two complementary theories that to date have been applied successfully, though in "piecemeal" fashion, to the assessment of end user computer competence (e.g., Marakas, et al., 1998; Karsten & Roth, 1998) and IS professional-end user interaction (Brown & Jones, 1998; Karsten, 2002). The goal of the proposed model is to "merge" the relevant principles of these complementary theories to provide a framework for organizing and understanding existing IS research, providing a platform for future research, and by providing IS professionals with theory-based principles and guidelines for assessing end user skills, designing better technical training, and responding more effectively and appropriately to end user needs. A brief overview of the self-efficacy and attribution literature follows.

The SCT construct of self-efficacy (Bandura, 1997) has offered insight into how individuals best acquire the skills and confidence necessary to accomplish tasks. Self-efficacy is the belief one has capability to perform a specific task (Bandura, 1997). Individuals base self-efficacy judgments on four main sources of information (enactive mastery, vicarious reinforcement, verbal persuasion, and emotional cues) that vary in appraisal value (Bandura, 1997). Training or teaching which provides the most valuable sources of self-efficacy information is likely to be more successful than training that does not (Bandura, 1997). Individuals weigh the contributions of these sources of information and generate a self-appraisal of their capability to perform the behavior of interest (Murphy et al., 1989). Individuals who perceive themselves capable of performing certain tasks or activities are defined as high in self-efficacy and are more likely to attempt and execute these tasks and activities. People who perceive themselves as less capable are less likely to attempt and execute these tasks and activities, and are accordingly defined as lower in self-efficacy (Bandura, 1997).

In the IS context, researchers have focused on computer self-efficacy (CSE), which "...refers to a judgment of one's capability to use a computer" (Compeau & Higgins, 1995, p. 192). Obviously, the desirable end result of training programs and the interaction between end users and IS professionals is individuals who would be characterized as high in computer self-efficacy (Compeau & Higgins, 1995; (Kelley, Compeau, & Higgins, 1999). To date, most self-efficacy research in the IS context has focused on the assessment of computer self-efficacy. Though plagued by definition and measurement issues (Marakas, et al. 1998), CSE research has been offered promising insights into the relationship between CSE, and variables such as prior computer experience, gender, and instructional style (Karsten & Roth, 1998).

Attribution Theory (AT) has provided additional insight into the mechanism of skill acquisition and the motivation to use those skills (Bandura, 1997) Stajkovic & Sommer, 2000).

Moreover, AT-based research has also identified the role perspective plays in the IT professional-end user relationship, and how differences in perspective and information processing biases can lead to the frustration and "finger-pointing" that frequently occurs when information systems fail to deliver as expected (Karsten, 2002). Attribution theory is a theory about how people make causal explanations. AT has shown that why we believe an event occurs influences our response to that event (Harrison et al., 1988; Kaplan & Reckers, 1985). Accordingly, the more accurately we are able to infer (i.e., attribute) the cause of an event, the more appropriate and effective our subsequent responses are likely to be (Kelley, 1973).

Importantly, AT offers insight into social interaction through its concern with both self perception-how we explain our own behavior and social perception-how we explain (i.e., attribute) the causes of the observed behavior of others (Kelley, 1973). More simply put, AT refers to how a person explains the causes of his or her own or another's behavioral outcomes. While individuals typically combine information in a logical manner to form attributions about their own and others' behavioral outcomes, AT research has demonstrated that attribution biases can distort the causal attribution process (Kelley & Michela, 1980). The following sections describe the personal and interpersonal consequences of attributions.

Regarding self-perception, prior research has recognized the important connection between self-efficacy and causal attributions (Bandura, 1997). Expectations of personal efficacy are strongly related to performance (Stakjovic & Luthans, 1998). However, research suggests that "... even under conditions of strongly perceived self-determination for performance, the reciprocal effects of performance feedback on subsequent self-efficacy will vary depending upon whether... feedback is causally attributed to internal or external factors." (Stakjovic & Sommer, 2000: 708). Consequently, personal attributions play a crucial mediating role in the development of self-efficacy. Stakjovic and Sommer (2000) have offered empirical support establishing direct and reciprocal links between causal attributions and perceived self-efficacy.

Regarding social perception, studies of mutually dependent, interacting individuals have found that causal attributions can influence the assessment of others' performance (Karsten, 2002), and remedial actions taken in response to observed performances (Kaplan & Reckers, 1985). Biased attributions may also encourage individuals to provide self-enhancing or self-protecting explanations that may not accurately reflect the causes of system success or failure (Brown & Jones, 1998). Unfortunately, self-serving explanations may result in divergent narratives that tend to simplify events and attribute cause to external factors, including the actions and competence of others. Brown and Jones (1998) caution that few situations are reducible to a single cause, and that biased attributions may obscure the real reasons for IS failures.

FUTURE RESEARCH

The preliminary review of the relevant literature supports the linkage among personal and interpersonal behavioral outcomes, self-efficacy, and causal attributions (Karsten, 2002; Kelley, Compeau, & Higgins, 1999). The initial review also supports the proposed merging and distillation of the two theoretical perspectives and their respective constructs into a social psychological framework.

The goal of the proposed model is to "merge" the relevant principles of these complementary theories to provide a framework for organizing and understanding existing IS research, providing a platform for future research, and by providing IS professionals with theory-based principles and guidelines for assessing end user skills, designing better technical training, and responding more effectively and appropriately to end user needs.

The model will be developed after an exhaustive examination and interpretation of SCT research, especially that related to the self-efficacy construct, the AT research related to the self-efficacy construct and interactive relationships, and the relevant IS research literature. Ideally, the resulting social psychological framework, will provide a foundation for enhanced insights into the IS professional-end user relationship, and which provides theory-based guidelines for research, training, skill assessment, and interaction that members of the IS community find productive and practical.

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DEVELOPMENT OF E-BUSINESS MODELS WITH DIFFERENT STRATEGIC POSITIONS AND COMPARISON OF BUSINESS PERFORMANCES WITH THE MODELS

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INTRODUCTION

E-business is different from conventional off-line based business in many ways. Not only the buying and selling of goods and services but also the servicing of customers and the collaboration with business partners are done on the Internet in an e-business. Information is accessed and absorbed more easily on the Internet than off-lines. Information is also arranged and priced in different ways on the Internet. These differences of an e-business relative to a conventional business create plenty of new opportunities for an e-business that may require different business strategies (Useem, 2000). Hence, it is necessary to develop a new business model with different strategy portfolios to seize these opportunities for a business success. The new business model for an e-business should consist of new coherent business strategies that incorporate the different business environment on the Internet, for a strategy is a carefully devised plan of actions to achieve goals of a company (Jutla et al., 1999; Kenneth et al., 1998; Timmers, 1998). The purpose of this study is to develop e-business models with different strategic positions in the value chain that accommodate unique demands in the e-business environment and then examine the association between e-business models and performance measures.

METHODOLOGY

Data Collection

500 survey questionnaires were e-mailed and 210 were mailed to those subject firms in the list of 2001 Annual Membership Directory of the 'Association of Internet Enterprise' in Korea. A

total of 130 responses were received representing a response rate of about 18.3%. 127 questionnaires were used for analysis after 3 survey questionnaires were discarded for incompleteness.

Analysis and Results

Content validity of the survey instruments was established through the adoption of standard instruments, suggestions in the literature, and pre-testing with professionals in the IS field (Kerlinger, 1986). Construct validity was evaluated by discriminant validity that is the degree to which a construct differs from other constructs and is usually verified through factor analysis. From the factor analysis, 6 strategic factors (Comparative advantage, Expansion, Process, Concentration, Low Price, and Product Improvement) with Eigen-value greater than 1 were selected. Since 3 strategic variables such as 'Promoting Advertisement for E-commerce,' 'Product Specialization,' and 'Targeting High Price Market' did not exhibit high discriminant validity (loadings < 0.5), only 19 strategic variables out of the initial 22 were loaded to 6 strategic factors. Internal coherence amongst determinants of each strategic factor was measured by the Cronbach's alpha coefficient, and the coefficients of all 6 strategic factors were larger than 0.5252, indicating that internal coherence among determinants is good (Nunnally, 1978). Each strategic factor identified by factor analysis has its own strategic behavior. These different behaviors are described in Table 1.

Table 1. Behavior of Strategic Factors	
Factor	Interpretation
Comparative Advantage	Focus on retaining comparative advantage on diverse fields such as product, cost, price, and human resource
Expansion	Focus on distribution channel and marketing effort to establish reputation within an e-business industry and to enhance customer service
Process	Focus on business process by investing research on business process, innovating the process, utilizing material effectively, and applying strict quality control
Concentration	Concentrate on a certain geographic area, a limited number of product, and inventory control
Low Price	Focus on low price to defeat competitors in e-business market
Product Improvement	Focus on continuous product improvement

Using the cluster analysis introduced by Hambrick (1983), 5 e-business models with various emphases on strategic factors were developed. The result of cluster analysis shows that 4 models (model 1, 2, 3, & 4) take multiple core strategies, while model 5 takes single core strategy, product improvement. Table 2 describes strategic behaviors of each model (cluster) in details. Each model behaves differently for competition.

Cluster	Strategy	Description
1	Comparative Advantage & Concentration	This model focuses on comparative advantage and concentration strategies. Companies utilizing this strategy involve product diversification, product and service development, skilled human resource arrangement, competitive pricing, low cost focus, advertisement, and low inventory level. They also are interested in providing a limited product to a limited market segment to focus on a market.
2	Expandability & Low Price	This model focuses on expandability and low price. Companies utilizing this strategy invest in Internet marketing to establish name on e-business industry, try to set up powerful influence on distribution channel, and expand customer service. They also focus on low price market.
3	Expandability & Product Improvement	This model focuses on expandability and product improvement. Companies utilizing this strategy rely on the expandability strategy and try to improve its product quality.
4	Comparative Advantage & Process Focus	This model focuses on comparative advantage and business process. In addition to the comparative advantage strategy, companies utilizing this strategy invest in research on innovative business process, quality control process, and better utilization of material.
5	Product Improvement	This model focuses only on product improvement. This strategy is simple and also powerful on the product innovation, but has limitations on environmental changes.

Since e-business models are developed and performance measures are measured, the relationship between e-business models and performance measures are investigated. This study conducted MANOVA tests to examine if e-business models affect their business performances. The results from this MANOVA test show that F-value is 8.98 ($P < 0.0001$), which means that the e-business models affect the business performance. Finally, the association between e-business models and performance measures is analyzed using Duncan grouping method where each business model is given a letter grade of A, B, and C for its performance in terms of four different performance measures. As shown in Table 8, Model 4 with the strategic emphases on 'comparative advantage' and 'concentration' has the highest performance mean and hence grade of A in all four performance measures. Model 3 with the strategic emphases on expansion and product improvement has the second highest performance mean in all four performance measures but earns 3 A's with 1 B. Model 2 with the strategic emphases on expansion and low price has the median performance mean but earns only 2 A's with 2 B's. Model 1 with the strategic emphases on 'comparative advantage' and 'concentration' has the second lowest performance mean and earns 2 B's, 1 A, & 1 C. Model 5 with the strategic emphasis on product improvement has the lowest performance mean and earns 2 B's with 2 C's.

Statistic	Value	F Value		Num DF		Den DF		Pr > F	
Wilks' Lambda	0.71693	3.48		12		315.14		<.0001	
		Return on Equity (ROE)		Return on Sale (ROS)		Return on Assets (ROA)		Sales Growth Rate (SGR)	
Cluster	N	Mean	D/G*	Mean	D/G*	Mean	D/G*	Mean	D/G*
4	20	3.9000	A	3.650	A	3.650	A	4.100	A
3	15	3.8000	A	3.467	A	3.533	A	3.667	B
2	26	3.6923	A	3.192	B	3.346	A	3.462	B
1	32	3.2188	B	3.000	B	3.125	A	3.094	C
5	33	2.5152	C	2.546	B	2.364	B	2.546	C

*: Duncan Grouping

CONCLUSIONS AND IMPLICATIONS

This study found that e-business models with dual core strategies outperform e-business model with one core strategy. Among those e-business models with dual core business strategies, model 4 with 'comparative advantage' and 'concentration' as core strategies performs best, which is followed by model 3, model 2, and model 1 in the order of the performance. According to the results of this study, companies should pay attention to the strategies such as 'comparative advantage' and 'concentration' to compete very best with other companies. The findings of the study have interesting implications for practice. E-business companies that want to compete with other e-business companies should focus on multiple core strategies rather than a single strategy. When they select one of e-business models with a strategic consideration, they should check where they put their emphases. The results of this study may be one of the guidelines in practice when companies choose their strategic e-business model.

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IS IS/IT GOING THROUGH AN IDENTITY CRISIS---AGAIN?

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ABSTRACT

Beginning in the late 1970s and carrying through the late 1980s, information systems/information technology (IS/IT) was struggling for an identity in the business community. IS/IT was generally regarded simply as a servicing function for the more important business functions of accounting/finance, marketing, human resources, and production/operations. Generally, the emphasis placed on IS/IT by top management was that it was a huge expense that needed to be controlled. Beginning in the late 1980s, a shift began to occur in the relative importance given to IS/IT. Organizations began to really recognize and grasp the strategic relevance of their IS/IT resources. This recognition increased at a rapid pace spurred on by two major economic and social events: (1) the extraordinary focus given to IS/IT during the "Y2K" years and (2) the meteoric rise IS/IT during the dot-com years. During these years, IS/IT virtually became "household words." Businesses felt the full impact of the strategic importance of their IS/IT resources and IS/IT programs in colleges and universities enjoyed booming enrollments. However, times have changed. Y2K was basically a non-event and the dot-com years have come an abrupt, economic end. As a result IS/IT may once again be struggling for an identity.

This is a pilot study that seeks to determine relative importance of IS/IT when compared to other business functions and resources. The study method makes use of scenarios or mini-cases. The scenarios were provided to students in the capstone business policy class and to students in the introductory required course of the MBA program. Demographic information included such things as the students' major, age, gender, work experience, etc.

Preliminary results suggest that IS/IT is indeed losing ground (identity) when compared to other business functions and resources. Study participants ranked IS/IT no higher than 3rd of the 5 functions/resources on any of the scenarios. Analysis is not complete with respect to how IS/IT fared when measured against the various demographic elements. Upon completion of the analysis, the study will be modified to correct for any problems discovered during the administration of the scenarios. The study will then be administered to various levels of management in 4 large manufacturing firms. It is anticipated that the study will find that IS/IT is facing a declining image in most organizations.

EMERGING CHANNEL PARTNER BENEFITS VIA ELECTRONIC DATA INTERCHANGE AND AUTOMATIC DATA COLLECTION

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ABSTRACT

With the ever increasing reliance upon technology, Automatic Data Collection (ADC) and Electronic Data Interchange (EDI) have become major factors in channel management and the establishment of partner relationships. In this paper, the authors propose and develop a paradigm for analysis of EDI/ADC, process and channel participation. EDI, the electronic exchange of business transactions between companies is examined in association with ADC, the collection of data by a firm with little or no human input. Process is defined as the application and use of EDI/ADC technology characterized by increased/decreased efficiency, value and channel system customization. Channel participation focuses upon the role that channel members hold in the value chain process characterized by power, politics, participation and exit costs. Establishment of Electronic Data Interchange linkages with the Automatic Data Collection of individual member firms offers significant potential for the transformation of relationships. Through these relationships, participants are able to observe both significant benefits as well as increased responsibilities. This paper presents a model to explore some of these rising effects upon channel relationships.

AN EMPHASIS ON HEURISTICS COMBINED WITH GA TO IMPROVE THE QUALITY OF THE SOLUTIONS: SOME METHODS USED TO SOLVE VRPs AND VRPTCs

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ABSTRACT

A survey of methods that have been used to solve the vehicle routing problem (VRP) and the time constrained vehicle routing problem (VRPTC) is reviewed in this paper. Emphasis is placed on heuristics that may be combined with genetic algorithms (GA) in order to improve the quality or efficiency of the solution. Artificial intelligence (AI) search heuristic and the genetic algorithm in particular will be reviewed. Next, a review of the issues and approaches that have been taken to make the GA an effective method of solving order-based problems is presented. While the GA has been applied to the traveling salesman problem (TSP) in some of the earliest studies, it was not particularly effective until some modifications of the original GA were developed that recognized the differences between solving order-based problems and function optimization. Particular emphasis will be placed on identifying high potential configuration and design issues as well as areas of conflict.

INTRODUCTION

The original GA operators of crossover and mutation were not very effective when used in order-based problems and in some cases were actually destructive. At this time, there are still some questions about the effectiveness of different crossover operators, appropriate mutation, population size, population replacement strategies, etc. All of these issues will be explored in this paper as we review the previous research for using GA to solve order-based problems and the VRPTC in particular. There are very few studies published where the GA has successfully solved the VRPTC. We will be exploring these in depth as well as building the foundations for our evaluations of these strategies and the development of this hybrid GA-based heuristic.

This paper is not intended to be a comprehensive review of all areas related to routing and scheduling. Rather, the intent is to examine research in areas that have inspired the formulation of

the models and methods developed and reviewed in this research. Some of these areas are developing so quickly that a comprehensive review is guaranteed to be obsolete upon presentation.

Relatively little research has been published on the VRPTC when compared to the volumes published on the TSP. The vast majority of research on using GA to solve order-based problems has been conducted on the TSP. Few papers have been published on research using GA to solve the VRPTC. When examining the available research, it was found that few of the available studies compare both the solution quality and efficiency of their methods. Typically, only solution quality is reported. Often simply graphics are used to present the results. There seems to be a lack of correct empirical studies in the area of GA research. Most available studies make simple comparisons of their results with those found in previous studies with no indication of compounding effects or statistical analysis. Some studies present their results with no comparisons at all. Perhaps this is due to the fact that this area of research is in its infancy.

SEARCH FOR SOLUTIONS TO PRACTICAL PROBLEMS

The trend in seeking new solutions for complex problems has in some ways completed a circle in the past 50 years. During the 1950s, the primary focus of research in this area was on developing effective heuristics to solve practical problems. Many of these heuristics were not elegant, but they were effective. In the next decade, the focus of research and development was on developing sophisticated mathematical optimization models. This was the period when classical optimization techniques were developed. While elegant mathematically, in general these algorithms failed to provide solutions to many of the practical problems faced by business. During the 1970s computational complexity was discovered. This was the period when the theory of nondeterministic polynomial (NP)-completeness was developed to explain intractable problems. An excellent explanation of the theory of NP-completeness and its implications for research and development is found in Garey and Johnson (1979). The discovery of this class of problems moved the focus of research from seeking optimal solutions to combinatoric problems, to a search for heuristics that are capable of solving practical problems.

This trend is continuing today. The primary difference between the heuristics developed during the 1950s and those of today is that much of the focus of today's heuristic development involves integrating and refining ideas and techniques from optimization and AI as well as exploring the hybridization of more than one method to solve a problem (Fisher & Rinnooy Kan, 1988). The focus of this research is on developing a new hybrid heuristic to solve a practical problem, the VRPTC, by integrating AI-search techniques and other more traditional heuristic techniques for problem solving. Generally, Neural Networks (NN), Simulated Annealing (SA), Tabu Search (TS), and Genetic Algorithms (GA) are included in the classification of AI-search heuristics (Glover & Greenberg, 1989). We have seen a great deal of growth in the area of applying AI-based search methods to solving practical problems. One example of the growth in research related to the application of genetic algorithms is seen in the growth of the GA bibliography published by David Goldberg. In 1986, this bibliography of GA literature consisted of 180 entries. An update published in July 1992 contains over 1200 entries. This represents a growth of publications in this area alone of over 37 percent annually (Goldberg, Milman & Tidd, 1992).

RELATIONSHIPS AND SOLUTION METHODOLOGIES

The VRP is defined as the task of finding the best set of routes from one or several depots to a set of customers using multiple vehicles. The solution must ensure that the demand is satisfied at each location. In addition to the above conditions, the typical VRP must comply with a variety of additional constraints that relate specifically to the problem being addressed. Some of these side constraints are typically vehicle capacity constraints and time constraints.

Two types of time constraints are typically found in VRPTC formulations: total trip time constraints and time windows in which each customer must be serviced. For total trip time constraints, the time typically includes driving and service time for each customer. A variant of this approach is to constrain each route to a specific mileage. Other constraints such as a precedence relation between customers to be visited are also found. The constraints that are utilized depend on the characteristics of the problem being solved. Several interesting variations are described in Assad and Golden (1988).

With the addition of time constraints, the VRP becomes the VRPTC. The standard VRP and VRPTC are often stated as CVRP or CVRPTW. For this paper we choose to use the notation RPTC, assuming that capacity constraints are implicit in the definition of the VRP. This paper will be defining the time constraint as a total time window in which each customer on a route must be visited. In essence, all customers assigned to the route must be serviced within the time window in which the route must be completed.

It has been shown that almost all vehicle routing and scheduling problems are NP-complete (Lenstra & Rinnooy Kan, 1981). Garey and Johnson (1979) have shown that the Hamiltonian circuit itself is NP-complete. The TSP is a prototypical NP-complete problem. It is easy to state and very difficult to solve. Essentially, the TSP can be defined as the problem of finding a minimum cost Hamiltonian tour between a set of locations on a hyper-plane. The VRP can be viewed as an extension of the TSP in that it has to find a set of tours using multiple vehicles that must visit all locations in the hyper-plane and comply with whatever other constraints are defined. The VRPTC is an extension of the VRP in which additional constraints on vehicle capacity and a time window for visiting each is defined.

Even for moderate tour sizes, it is unrealistic to solve the TSP directly by means of an integer programming code. The TSP is usually solved by means of specialized algorithms. The TSP is a pure ordering problem which has been found to be NP-complete in most cases. There are a few cases where the TSP is not NP-complete, but they do not apply to this research.

The TSP is central to most research in routing and scheduling today. The routing and scheduling of vehicles, while important, is only one practical application of this class of problems. This paradigm can be expanded to telecommunications network configuration and design with no changes and to a wide group of other areas with little if any changes in basic methodology. In fact, Gilbert Laporte, in his reviews of methods for solving the TSP and VRP, cites several non-transportation-oriented applications of TSP and VRP (Laporte, 1992a, 1992b). Examples as diverse as computer wiring, dartboard design, hole punching, network routing, network design, and circuit switching--all use the TSP or VRP as their basic paradigm.

HEURISTIC BASED METHODS OF PROBLEM SOLVING

Development of heuristics to solve the TSP, VRP, and VRPTC can be divided into research focused on developing heuristics with good worst-case performance and heuristics with good empirical performance. Many heuristics that have poor worst-case performance in fact have good performance when tested empirically. Most of the effort is in developing heuristics with good empirical performance (Laporte, 1992a).

Heuristics with good empirical performance include tour construction and tour improvement procedures. Often, problems are solved by integrating one heuristic or approach with another. Another common method is based on sequentially executing multiple good heuristics or techniques. This approach is more often seen when solving more complex problems like the VRP and its extensions. We have examined several cases where a tour improvement procedure is executed after the main algorithm is complete. This section includes a discussion of general classes of heuristics followed by a presentation of the AI-based methods for solving the VRPTC.

SOLVING THE VRPTC WITH AI SEARCH TECHNIQUES

The heuristic techniques NN, SA, TS, and GA can be classified as AI-search techniques (Glover & Markland, 1990). Currently, there is a great deal of activity in the development of new heuristics based on AI-search techniques or on incorporating combinations of traditional heuristics, exact algorithms, or other AI heuristics in new combinations to more effectively solve real-world problems. At this time, the most promising techniques seem to be TS and GA. As we will see later, these techniques have a great deal in common. The largest difference is that GA approaches the task of finding a solution by evolving or refining a population of potential solutions in parallel while the TS approach seeks to evolve the one best solution.

CONCLUSION

This paper has reviewed the focus on developing solutions to practical business problems. A brief overview of the relationship between the TSP, VRP, and VRPTC was introduced. A high-level overview of exact methods for solving these problems was presented. Heuristic approaches that have proved successful in solving these problems were reviewed with an emphasis on heuristics that may be combined with other algorithms. The state of a class of heuristic algorithms known as AI search techniques was reviewed. These include NN, SA, TS, and GA. A brief description of each of these techniques was presented along with a short review of how they fare when attempting to solve the TSP, VRP or VRPTC. We found that the NN approach, while still viable, appears to be the poorest of the AI-search approaches, while TS and GA appear to be the best.

As we have seen in the review of GA literature, there are several viable heuristics available for solving the VRPTC. Often the best results are obtained by integrating several previously defined heuristics in such a way as to obtain superior results. We see two approaches for implementing GA-based solutions to the VRPTC. One method, used by Thangiah (1993) is to use GA for one stage of solving the problem and sequentially apply other heuristics. Another approach is to use GA as a shell and to incorporate high-quality heuristics into the GA operators themselves. It has been

shown that heuristics can be incorporated into crossover, mutation, and improvement operators. Much of this work has been validated on the TSP.

There is little agreement as to which design decisions or parameter setting lead to the development of a superior GA for solving order-based problems. TSP or VRPTC can be represented using path representation or edge representation. Path representation is the most common, but GA that have utilized edge representation perform well. The representation scheme selected should closely match the problem at hand. The representation scheme also limits the types of crossover and mutation operators that are viable. It appears that a steady state evolutionary strategy may be superior to a generational evolutionary strategy. The only risk in steady state population management appears to be premature convergence. Syswerda (1991) found that steady state with exponential ranking for replacement performed best.

There is no agreement in the literature as to the best population size and whether it should be seeded with an initial good solution. Though seeding the initial population may have little effect on the solution quality, we suspect that it will greatly affect the efficiency.

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AN EMPHASIS ON THE TSP AND THE VRPTC: AN EXPLORATORY STUDY OF GENETIC ALGORITHMS

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ABSTRACT

The purpose of this paper is to explore the application of an artificial intelligence search technique, the genetic algorithm (GA), to solve order-based problems. The emphasis of this study is on exploring GA-based solutions for the traveling salesman problem (TSP) and the time constrained vehicle routing problem (VRPTC).

INTRODUCTION

This study begins by reviewing the state of genetic algorithm development in the early 1990s and other approaches for solving problems where ordering is important. Particular emphasis is placed on identifying issues and areas of research on the use of genetic algorithms for ordering problems. An evaluation of various GA configuration and design parameters used in developing GA-based heuristics to solve the TSP is conducted. This evaluation is conducted using the genetic algorithm testing system (GATS) developed for this study. The results obtained from this test are used to develop a GA-based heuristic for solving the VRPTC (GA-VRPTC). The GA-VRPTC is evaluated through the use of empirical computational testing on standard problems selected from the literature.

SOME APPLICATIONS

A new TSP or VRPTC heuristic has many potential real-world applications. Daily, we are surrounded by problems that involve routing and scheduling. One area that comes to mind is delivering goods and services in an efficient manner. In 1990, the Gross National Product (GNP) was \$5.465 trillion. Transportation of goods and passengers represents a significant (17.3 percent) portion of the GNP (ENO Transportation Foundation, 1991).

One tends to think of routing and scheduling applications solely in terms of vehicles moving goods or services to and between customers. This view is very limited in reality. Many of our

leading edge technological applications rely on efficient and effective solutions to routing and scheduling problems.

Telecommunication network design and implementation is one of the many non-traditional areas that need to address routing and scheduling issues. Several problems found in the telecommunication field are very similar to those problems faced when trying to efficiently deliver goods and services. When addressing a telecommunications problem, one can view the customers to be serviced as the nodes on a telecommunications network. Demand for goods and services can be viewed as the requirement to transmit a certain volume of data within a specific time period. The selection of routes is virtually the same, as there is a need to find the most efficient routes through a network. The *vehicles* can be the number of a certain capacity transmission media required between two nodes, or in the design stage *vehicles* can represent bandwidth requirements and the routes selected as the configuration for connecting various nodes in the network. And this is, in fact, a busy area.

BUILDING UPON PREVIOUS RESEARCH

The general area of routing and scheduling has a high potential for the development of practical applications. In reviewing new applications in routing and scheduling, Assad and Golden (1988) found that the area of vehicle routing is distinguished by a highly successful interplay between algorithmic techniques and the development of effective routing systems for industry. In addition to the high potential for developing practical applications, solving the vehicle routing problem is an interesting and challenging academic exercise in its own right. It has been found in several comprehensive studies that almost all vehicle routing problems belong to the class of combinatoric problems known as nondeterministic polynomial complete or NP-complete [hard] (Garey & Johnson, 1979; Haimovich, Rinnooy Kan & Stougie, 1988; Soloman, Baker & Schaffer, 1988).

When a problem is classified as NP-complete or hard, no exact method to solve the problem in polynomial time is known. As the problem size grows, the time required to find an exact solution tends to grow at an exponential rate. An *efficient* algorithm is an algorithm whose execution time can be bounded by a polynomial function written in a reasonable term of the problem size. To date, no *efficient* general algorithm has been found to generally solve the relatively simple traveling salesman problem (Miller & Pekny, 1991).

Prior to solving a routing problem, an appropriate model of the routing problem at hand must be formulated. This requires that a choice of solution methods must be made. The selection of a solution method requires a tradeoff between accuracy and execution time or tractability. For many small problems, an exact or optimal solution can be found in some reasonable amount of time. For larger, more complex problems, the use of exact procedures to solve routing problems may not be possible. Most practical-size problems exceed the capabilities of exact computational procedures (Ballou & Agarwal, 1990).

In this case, a choice must be made among the various heuristic or approximation methods available. Heuristic or approximation approaches find solutions that, while not exact, are satisficing. Often the solution arrived at by the heuristic is near optimal or optimal. There is no guarantee of

optimality, however. Most routing and scheduling problems are solved using heuristics (Assad & Golden, 1988).

This study does not examine exact solution methods for solving routing problems, but rather concentrates on heuristic or approximation approaches. The focus of this study is to explore a subclass of heuristics known as artificial intelligence search heuristics, specifically-- Genetic Algorithms (GA).

ROUTING AND SCHEDULING PROBLEM DEVELOPMENT

A major component of most routing and scheduling problems is the traveling salesman problem (TSP). While this study also explores the more complex Vehicle Routing Problem with Time Constraints (VRPTC), much of what has been learned by those who attempt to solve the TSP can be transferred to the VRPTC. One of the more common methods of solving the VRPTC is to execute a series of heuristics to either assign customers to routes and then solve the basic TSP, *cluster first, route second*, or to establish a good routing first and then partition the customers on the route among the vehicles available, *route first, cluster second*.

The TSP is essentially a simple ordering problem. This simplicity makes it a good test bed to evaluate new heuristics and to determine the effect of changes in parameters on the solution quality without multiple confounding variables. Often it is more efficient to develop and test new approaches using the TSP prior to attempting a more complex problem. Our interest in examining the TSP covers both of these reasons. Most of the research in the application of GA to routing and scheduling has been evaluated using the TSP. It is only in the latter 20th century that anyone attempted to solve the more complex VRPTC using GA.

Just because an approach is viable for solving the TSP does not mean that it will perform as well in the more complex VRPTC, where the objective is more complex and involves the interaction of more variables and constraints. In this paper we will explore approaches to solving the TSP as well as use it as a test bed to validate the approaches selected in the design of this hybrid GA-based heuristic.

TRAVELING SALESMAN PROBLEM (TSP)

The traveling salesman (TSP) is a classic routing problem in which the objective is to conduct a minimum cost Hamiltonian tour. A Hamiltonian tour visits each city only once. The TSP is a combinatoric problem that can be solved by either exact approaches or the use of the heuristic approach. The integer programming formulation is a more precise definition of this problem. The TSP forms the basis for most routing problems. It will be shown that the Vehicle Routing Problem (VRP) can be developed from the TSP problem by adding further constraints that are seen in many real-world routing problems.

VEHICLE ROUTING PROBLEM (VRP)

Dantzig and Ramser introduced the classic vehicle routing problem in 1959. The vehicle routing problem is an extension of the TSP in which multiple tours are defined--one for each vehicle

available. As in the TSP, all cities must be visited. The objective is to find the minimum cost set of tours that allow all cities to be visited only once. Figure 3 is a pictorial description of a VRP for a fleet of three vehicles.

GENETIC ALGORITHM (GA)

Genetic algorithms were first developed by John Holland and several of his students at the University of Michigan in the early 1970s (Holland, 1975). Genetic algorithms derive their name through the use of operators that mimic the evolutionary operations that occur in nature to solve problems. In keeping with the biological theme, a new vocabulary is typically defined for describing GA features. Some examples of GA terms are listed below.

Chromosome	String
Gene	Feature, character, or detector
Allele	Feature value
Locus	String position
Genotype	Structure of a chromosome
Phenotype	Parameter set, alternative solution a decoded structure
Epistasis	Nonlinearity

Source: Goldberg, D.E. (1989). *Genetic algorithms in search, optimization and machine learning*. Reading, MA: Addison-Wesley Publishing Company, Inc.

GA mimics the evolutionary functions of nature. Instead of trying to find a single best solution, GA evolves a population of potential best solutions. If chromosomes exhibit traits that lead to good solutions, they are rewarded through selection for reproduction. Through this process, good genetic material is combined and a directed search for solutions continues. The trait that multiple solutions are being evolved at the same time is called implicit parallelism. This implicit parallelism is one of the major differences between TS and GA. Outlined below is a simplified flow of GA.

1. Initialize a population of chromosomes.
2. Evaluate each chromosome in the population.
3. Create new chromosomes by mating current chromosomes: apply mutation and recombination as the parent chromosomes mate.
4. Evaluate the new chromosomes and insert them into the population.
5. If time is up, stop and return the best chromosome; if not, go to 3.

Source: Davis, L. (1991). *Handbook of genetic algorithms*. New York: Van Nostrand Reinhold.

GA efficiently exploits historical information to speculate on new search points with improved performance over more traditional techniques. One of the central themes in GA research

is robustness. GA exhibit much of the robustness of survivors in nature. These algorithms have been empirically proven to provide robust search in complex spaces (Davis, 1991).

One method of improving heuristics is to integrate existing heuristics in new and potentially more powerful ways. The method of solving routing problems by sequentially executing heuristics was previously discussed. Often the heuristics that are integrated in this manner support the *route first* or *cluster first* approach to solving the VRPTC.

SIGNIFICANCE AND CONTRIBUTIONS OF RESEARCH

The significance and some of the contributions of this research are listed below.

1. Further the development of standards for building order-based GA by conducting empirical evaluation of various design and configuration options.
2. Design and implement a portable genetic algorithm testing system (GATS).
3. Design and implement an *a priori* statistical design for an in-depth computational comparison among heuristic alternatives.
4. Determine if the seeding of a GA initial population with a good solution will enhance the efficiency of GA.
5. Compare of several GA configuration and design options on solving a set of standard TSP.
6. Develop a GA-based heuristic to solve the more complex VRPTC (GA-VRPTC), building on the results obtained in the previous step.
7. Compare the results obtained with GA-VRPTC heuristic results on standard VRPTC with those obtained by other more traditional heuristics.

CONCLUSION

This paper explores the potential of GA to solve order-based problems with particular emphasis on solving the TSP and the VRPTC. As a result of a thorough review of current literature, several issues related to developing GA in order to solve ordering problems were uncovered.

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INFORMATION TECHNOLOGY PROFESSIONALS OR ACCOUNTANTS: THE BEST CHOICE FOR SARBANES-OXLEY COMPLIANCE

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ABSTRACT

Much has been written in the business press and in academic journals about the Sarbanes-Oxley Act of 2002 (SOA) and how it will affect corporate governance and the practice of auditing and public accounting. This paper outlines the opportunities for IT professionals in designing the systems that will enable companies to comply with the SOA. The paper also contrasts the qualifications of IT professionals with respect to SOA compliance work with those of public accounting firm staff members.

INTRODUCTION

The Sarbanes-Oxley Act of 2002 (SOA) was passed in the United States (U.S. Code, 2002) in response to a series of significant failures in corporate governance, including Enron (Schwartz, 2001) and the related failure of accounting firm Arthur Andersen (Eichenwald, 2002), HealthSouth (Day, 2003), Tyco (Sorkin, 2002), and WorldCom (Moules and Larsen, 2003). Even Europeans, many of whom were convinced that this rash of management frauds were a result of American's hyper-capitalism mania and could never happen in the refined atmosphere of the continent, found that they were not immune when Parmalat's \$15 billion in understated debt and huge overstatements of sales and earnings were exposed (Adams, 2003).

REQUIREMENTS OF THE SOA

The SOA includes 11 Titles (USC, 2002). Title I establishes the Public Company Accounting Oversight Board. Title II defines auditor independence. Title III discusses corporate responsibility. Title IV discusses enhanced financial disclosures. Title V discusses securities analyst conflicts of interest. Title VI discusses the Securities and Exchange Commission (SEC) resources and authority. Title VII discusses the studies and reports that must be completed. Title VIII discusses corporate and criminal fraud accountability. Title IX discusses white-collar crime penalty enhancements. Title X discusses corporate tax returns. Title XI discusses corporate fraud and accountability.

ROLE OF THE ACCOUNTING INDUSTRY IN SOA COMPLIANCE

The accounting industry has reacted rapidly to the passage of the SOA (AICPA, 2002a; AICPA, 2002b, AICPA, 2002c). Its reactions have been largely defensive. Many observers believe the accounting industry is at least partially responsible for not detecting many of the recent frauds and accounting irregularities (Rezaee, 2003; Velayutham, 2003). Indeed, it is interesting to note that since 2002, when many news stories began reporting on these frauds and accounting failures, the news media has referred to “the accounting industry.” In earlier years, the business was typically referred to as “the accounting profession.” When the SOA was passed many accountants saw it as a combination of things. They saw it as an opportunity to repair their tarnished reputation, a chance for real reform, and even a way to replace lost consulting revenues with a new (and perfectly legal under the SOA) revenue stream: consulting services designed to help companies comply with the SOA (Munter, 2003). Needless to say, some accounting industry critics found this turn of events ironic.

Need to Please Clients

Since the 1980s, audits have been viewed increasingly as a commodity service. One audit firm is as good as another, and no client really cares if they received a quality audit as long as they received the auditor’s unqualified opinion (Zeff, 2003). This perception of audit services as a commodity lead to severe price competition (Healy, 2003). Accounting firms responded by offering a variety of consulting services. These services had higher margins than audit work and could be sold to audit clients. As clients provided more and more consulting revenues to their audit firms, the objectivity and independence of auditors came into question (Briloff, 1987; Stevens, 1991).

By the beginning of the 1980s, the large accounting firms had all concluded that profit margins on audits would be painfully thin, particularly relative to those on other financial services (Stevens, 1991). Their response was to diversify into other businesses- notably consulting (Zeff, 2003). Since audit quality did not matter to clients, auditors became more and more desperate to curry clients’ favor by maintaining friendly relationships with client accounting managers and top executives so that the firm could bid on more and more lucrative consulting work with the client. Client retention and expansion of non-audit fee revenue became important parts of accounting firm employees’ compensation arrangements. For partners in the firms, it was a critical element (Healy, 2003; Zeff, 2003).

Ability of Accounting Firms to Provide SOA Assistance

Clearly, accountants and public accounting firms have the technical skills to provide help to companies that need assistance in complying with SOA (Coustan, et al., 2004; Winters, 2004). Lanza (2004) suggests that company’s internal audit staff might be valuable consultants for SOA compliance and systems design and development. We argue that many of the important elements required by SOA might be best addressed by using the consulting expertise of IT professionals.

IT PROFESSIONALS AND THE DEMANDS OF THE SOA

An understanding of internal control demands an understanding of the underlying accounting and administrative systems of the company (Hall, 2004). As every business of any size has computerized its accounting and administrative systems, the people who know these systems well and who understand their design are increasingly members of the ranks of IT professionals. In this section, we argue that IT professionals, both inside the company and in consulting firms outside the company, can provide valuable services to the company as it attempts to comply with the internal control standards set by the SOA. Further, the IT professionals who have gone on to become lawyers practicing in the area of high technology are especially well-qualified to offer SOA consulting services because of their unique combination of IT knowledge and legal training.

Technical Skills and Business Knowledge of IT Professionals

IT professionals have been engaged in the design and implementation of systems for decades, far longer than accountants have been seriously involved in these issues (Gelinias and Sutton, 2002). They have a keen understanding of what it takes to make these systems work. Increasingly, IT professionals are educated, trained, and respected as business analysts as well as for their technical knowledge.

Lanza (2004) notes that two of the most important elements of any SOA compliance program is the proper use of data analysis tools and data mining software. Data analysis functions include the use of query tools that allow users to ask questions of the enterprise-wide information system (Gelinias, 2002). In large organizations such as those subject to SOA, this system will, in most cases, have been designed and implemented by the company's IT staff. It will definitely be maintained by IT staff. The people who know the most about the enterprise-wide information system will always be IT professionals. Many companies have undertaken major knowledge management initiatives in recent years (Angus, 2003; Awad and Ghaziri, 2003). These initiatives have, in most cases, been designed and implemented by IT professionals. As SOA requirements become part of the fabric of large companies, they will be included as part of these companies' knowledge management systems (Lanza, 2004).

Independence of IT Professionals

Although IT professionals employed by the company are not, by definition, independent, they often operate with considerable latitude. Because IT professionals have a level of expertise that can be critical to company operations, they often can derive a level of mystique that provides a level of independence (Burns and Haga, 1977). External consultants that offer companies IT advice are likely to be much more independent than public accounting firms and they are not tarnished by association with the very evils that prompted the legislation.

CONCLUSION

We have examined some of the requirements of the SOA and what companies must do to their accounting and internal control systems to comply with the law. After considering accountants in the company and external public accounting firms as likely candidates for the job of advising companies what they must do to comply with the SOA, we find them lacking in the key elements of technical expertise, independence, and overall business knowledge. We argue that IT professionals have higher degrees of relevant technical expertise and sufficient levels of overall business knowledge to be very qualified to advise companies on SOA compliance efforts, especially if their technical knowledge is augmented by legal training. This legal training is more relevant to some areas of SOA compliance than others. In the final analysis, IT professionals have a strong advantage over the accounting industry in this comparison: IT professionals are not tarred by an association with the frauds, irregularities, and crimes that motivated the SOA's passage. Accountants in general and public accounting firms in particular, cannot make that claim.

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AN INTEGRATION OF SYNTAX, SEMANTICS, AND THE THEOREM PROVER USING NATURAL LANGUAGE: ANSWERING QUESTIONS IN ENGLISH

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ABSTRACT

The achievement of a non-linguistic representational level for the content of natural language material constituted an advancement beyond the “interlingua” concept (intermediate language) employed in the design of mechanical translation systems as an intermediate step in the translation of material among several languages in the early 1970s. The challenge of programming a computer to use language in the early 1970s involved the challenge of producing intelligence. Thought and language are closely interwoven so that the future of research in natural language and computers will be neither a study of linguistic principles nor a study of “artificial” intelligence, but rather an inquiry into the nature of intelligence itself.

INTRODUCTION

The problem of widening the scope of knowledge involves much more than building bigger memories or more efficient lookup methods. If we want the computer to have a large body of knowledge, the information must be highly structured. The critical issue is to understand the kinds of organization needed. One of the reasons this natural-language system was able to handle many aspects of language that earlier systems could not was that it has a deep understanding of the subject discussed. There was a body of theorems and concepts associated with the words in the vocabulary, and by making use of the knowledge in its question-answering and action, its language behavior became more like ours. We cannot give up this insistence that the computer must know what it is talking about.

INTEGRATION OF KNOWLEDGE

We need a way to integrate large amounts of heterogeneous knowledge into a single system that can make use of the knowledge. At the same time, we cannot let the system become overburdened and inefficient by insisting on generality and uniformity. We want the advantages of

special types of knowledge and structure that can come from limiting the subject to a small area, but at the same time we must have the flexibility that allows knowledge of different types to interact.

Many different approaches can be taken towards higher organization of knowledge. We may want to think in terms of a *block-structure* of contexts, each of which carries its own special vocabulary and information. We may think of a network in which we can consider the *distance* between two concepts or words. It may be possible to use a set of specialized *sub-routines* to deal with different kinds of situations. Even for something as seemingly simple as children's stories, there are tremendous complexities, and a well-structured approach is needed.

The problem of learning is of great interest not only to those working on practical computer systems, but also to psychologists interested in understanding how learning takes place in human beings. We need to understand how the amount of knowledge we already have affects the amount and the way we can learn. Working on a natural language program offers several advantages for studying problems of knowledge and learning. Language represents a body of highly complex knowledge, which itself can provide a rich field for learning tasks with a wide range of difficulties. In studying the way that a computer could accept new information in natural language, we are studying a key area in learning. We need to explore in what ways knowing about its own mentality could allow a computer to really learn.

Finally, we have the problem of speech communication with computers. Again, the issue is not one of more efficient hardware, but one of knowledge. Spoken language calls on the listener to fill in a great deal from his own knowledge and understanding. Words, phrases, and whole ideas are conveyed by fragments and mumbles that often serve as little more than clues as to the intended meaning. People can communicate under conditions where it is nearly impossible to pick out individual words or sounds without reference to meaning. The need for a truly vertical system is much greater for speech than for written language. The analysis at even the lowest level depends on whether the result "makes sense."

In this paper we integrated the syntactic, semantic, and deductive programs in a flexible way. We allowed meaning to aid in the parsing of a sentence. Our semantic interpretation was guided by logical deduction and a rudimentary model of what the speaker knows. For spoken language, this must be expanded. Perhaps we might have looked for fragments of sentences and used their meaning to help piece together the rest. Possibly we could have created a unified system in which the deductive portion could look at the context and on the basis of meaning and the audible clues in the utterances, propose what it thought the speaker might have said. It might be possible to have a more multi-dimensional analysis in which features such as voice information could be used to recognize important features of the utterance. This is not stating that syntax should be eliminated in favor of some sort of vague relational structure. Often the most important clues about what is being said are the syntactic clues. What is needed is a type of grammar that can look for and analyze the different types of important patterns rather than getting tremendously involved with finding the exact details of structure in a fixed order. The grammar in this paper is a step in this direction, and the use of programs for grammar gives the kind of flexibility that would be needed for doing this kind of analysis. In the early 1970s, the system in its form could not be adapted to handle spoken language, but its general structure and the basic principles of its operation might be used later.

USE TO BE MADE OF FINDINGS

The study proposed is basic; it strives for results which will open avenues of applied research in man-machine communication to the benefit not only of information retrieval *per se*, but of a broader field of Information Technology (IT). Research could help to improve mechanical teaching techniques and mechanical translation, each of which depends upon the effectiveness of communication at the man-machine interface.

One may view the process of instruction as a form of information retrieval, particularly in the case of *heuristic teaching*, with the consequence that the results we wish to achieve can form the direct basis for new direction in mechanical instruction research, i.e., a highly interactive *Socratic* form of pupil-machine interaction.

AN INTRODUCTION TO LISP: LIST STRUCTURES

LISP is a programming language John McCarthy developed with his students while he was on the faculty at the Massachusetts Institute of Technology. LISP is not an algebraic language, although MLISP, a dialect of LISP, is algebraic. LISP may be characterized as a functional language, as a recursive language, as a symbolic language, as a list processing language, and as a logical language. The basic building blocks of LISP are atoms and lists. An atom is either a string of alpha characters containing no delimiters or a number. For example, some atoms are:

236 0.178654 BIGJULIE A3*76 ANEXTRALONGSTRINGOFLETTERS

In the NLP system, atoms are used for such things as English words, syntactic classifications, semantic indicators, names of relationships, actions, properties, specific objects and events, and the names of variables. The most important data structure is a *list*. On the surface, a list in LISP is somewhat similar to an array in FORTRAN or ALGOL. It is an ordered collection of data; thus, (1 7 5 3 8 THETA) is a list of six elements. Lists can be made up of other lists besides just atoms. An example of this follows:

((THE (BIG YELLOW CAR)) (IS ((A MERCEDES BENZ)))).

This is a list of two elements where the sub-lists are divided into lists themselves. This ability to nest lists within lists gives LISP its characteristic parenthesized appearance and enables it to build and manipulate tree-like data structures. The list containing no items is written as () and is called NIL. It is used to represent the logical value *false*. The atom T is used to represent *true*.

The significance of a list is up to the programmer. It may be a list of separate entities, such as the meanings or parts of speech of a word, or the words in a sentence; or instead particular positions within the list may also be assigned special significance. For example, we may use four-element lists such as (# NEXTTO A B) to represent a two-place relation, putting the relation name in the first position. A node of the parsing tree produced by the syntactical component of our system is a three-element list whose members include a list of the syntactic classification's subject, object, and predicate with their modifiers as sub-lists.

EVALUATION

LISP programs operate by interpreting lists in a special way, known as evaluation. The first element in the list is interpreted as the name of a function. For example, the list (MINUS 4 3) when evaluated returns a value of 1, while (TIMES 3 2 1) evaluates to 6. In the interactive mode operation of LISP, expressions are typed at a terminal and their value is typed back by the system. When the members of the list are used as arguments, they are in turn evaluated. The list (PLUS(TIMES 7 6 11 4)8) tells LISP to apply the function PLUS to three arguments, the first of which is produced by applying TIMES to 7 and 6, the second by applying PLUS to 11 and 4, and the third simply being the number 8. LISP always uses this prefix notation for operations rather than the more useful infix notation like $7*6 + (11-4) = 8$

FUNCTIONS

The idea of a function is used more widely in LISP than in other programming languages. In addition to built-in functions, the user writes programs by creating his or her own functions. This is done in the following way. We normally use the DEFINE function to create new functions. This function has one argument that is a list of functions to be defined. Each function to be defined is itself a list of two elements. The first of these elements is the function name and the second is the function description. Thus, we might input:

```
DEFINE(((RHO x1) (SIGMA x2) (TAU x3)))
```

where x_1 , x_2 , and x_3 stand for the three function descriptions. This would serve to define three functions named RHO, SIGMA, and TAU, respectively. The expression (((RHO x_1) (SIGMA x_2) (TAU x_3))) is the list of arguments of DEFINE. There is in fact only one such argument, namely (((RHO x_1) (SIGMA x_2) (TAU x_3))) since DEFINE always has exactly one argument as mentioned above. This argument is itself a list of three S-expressions, namely (RHO x_1) (SIGMA x_2) and (TAU x_3). An S-expression is either an atom or a left parenthesis followed by a sequence of S-expressions separated by blanks or commas and followed by a left parenthesis. Note that RHO, for example, is taken to be the name RHO and not the quantity RHO signifies.

Any legal specification of a function is permissible in DEFINE. In particular, we may define one function to be exactly the same as another. Thus, the functions:

```
DEFINE ((RHO PLUS)(SIGMA TIMES)(TAU DIFFERENCE))
```

would have the effect of defining RHO to be a function with exactly the same effect as PLUS, and similarly SIGMA as TIMES and TAU as DIFFERENCE. Thus (RHO(RHO(SIGMA 2 5) (TAU 4 3 12)) would have the same effect as (PLUS(PLUS (TIMES 2 5)(DIFFERENCE 4 3))12)--namely it would produce the value 23. This is true because PLUS, TIMES, and DIFFERENCE are legal specifications of functions in LISP; they are, in fact, part of the standard collection of LISP functions.

VARIABLES

In the functions previously defined, the letters X, Y, and Z could have been used to represent variables instead of constants. Any non-numeric atom can be used as a variable name. A value is

assigned to a variable in two ways. One way is by the calling of functions. Another way is by using the replacement function SETQ which acts like the "=" of FORTRAN. Evaluating the expression (SETZ BREAD (PLUS 2 2)) would cause the variable BREAD to have the value 4. If we now evaluated (TIMES BREAD BREAD) the result would be 16.

RECURSION

Recursion is possible in LISP. The property of recursiveness is much more powerful in LISP than it is in ALGOL. In ALGOL, there are functions that call themselves either directly or indirectly. If the function A contains a call to itself, then it is said to call itself directly. If the function A calls B and the function B calls A, then it is said A calls itself indirectly. Generally, if there are several functions A_1, A_2, \dots, A_n such that A_i calls A_{i+1} for $1 \leq i < n$, and A_n calls A_1 , then it is said that A_1 calls itself indirectly. In FORTRAN this is not possible. Thus, ALGOL allows functions to be recursive, whereas FORTRAN does not.

In LISP, when a function is defined, the function can be recursive like ALGOL. But in LISP, the concept of a recursive function as defined in logic is used. When the factorial of n is defined, this is defined accordingly-- n is multiplied by the factorial of $n-1$. This could be called a circular definition, because the word *factorial* uses itself in its definition. Ordinarily, this would make the definition improper, but if it is specified that the factorial of 0 is 1, the definition does, in fact, give the value of the factorial of any positive integer. In particular, the factorial of 1 is 1 times the factorial of 0, that is 1. The factorial of 2 is 2 times the factorial of 1, that is 2. Thus we can obtain the factorial of n .

CONCLUSION

The great effectiveness of a natural form of query and response in the information retrieval process, particularly in facilitating an adequate match between what is asked and the response which forms a reply, was emphasized in this paper. A successful outcome of this research into the linguistic and logical principles by which this natural form of interaction is possible will be of the greatest usefulness in and have a direct effect on the design of the next generation of information retrieval systems.

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AN EARLY APPLICATION OF THE SYNTACTIC ANALYSIS ALGORITHM: DATA STRUCTURING AND INFERENCE

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ABSTRACT

This paper outlines problems and explains an early 1970s data structure developed for a natural language question-answering system. This data structure is based upon a high-order calculus. This data structure allows for a greater degree of expressiveness and is suitable for extensive logical deduction.

INTRODUCTION

The storage and subsequent retrieval of large amounts of information posed some interesting problems concerning data structures and their utilization for efficient retrieval purposes in the early 1970s. These problems became more acute when the system had to deal with the answering of questions posed in English. This is due to the fact that a natural language question-answering system must be able to synthesize retrieved information in order to construct the answer to any given question. The internal structure of such systems, therefore, must reflect subtle semantic differences.

EARLY RESEARCH ATTEMPTS

Early attempts to design question-answering systems were based in part upon the logical properties of the propositional calculus (Darlington, 1964). The DEACON and PROSYNTHEX systems relied heavily upon the syntactic properties of natural language. Simmons (1966, 1968) developed two very good surveys of natural language question-answering systems.

Due to the inadequacy of the propositional calculus as a data structure model for question-answering, a variety of other approaches using a limited number of predicates were reported. Robinson (1965) developed a semi-decision algorithm for the first-order predicate calculus. Green and Raphael (1968) considered this to be a much more reasonable structure for representing and manipulating natural language information.

It became evident that even the first-order predicate calculus could not represent much of the information that is encountered in natural language. Robinson (1965) developed a semi-decision procedure for a high-order representation. The use of a high-order structure as the basic scheme for

the representation of natural language information has far more potential than any of the lower-order schemes. One basic advantage in using the high-order representation lies in the fact that anything that can be represented or manipulated within a lower-order representation can be accomplished more efficiently in a high-order representation. In addition, the embedding properties of the high-order structure allow many things to be represented that were heretofore impossible to represent.

It is important to note that the concept of using a data structure that permits the embedding of information is not unique to the structure developed in this paper. Simmons, Burger and Schwarcz (1968) used a similar type of representation scheme that was the best structure available for natural language question-answering in the late 1960s. However, the structure did not have the flexibility to allow powerful deduction (Schwarcz, Burger & Simmons, 1970).

The embedding properties of both approaches make the use of lower-order structures less attractive for natural language question-answering systems. Motivation for the use of the new high-order structure is based upon a logical calculus. A formal definition of this high-order structure, along with a number of annotated examples demonstrating its application, will be given.

STRUCTURAL REPRESENTATION FOR NATURAL LANGUAGE INFORMATION

Suppose that it is necessary to represent the sentence "John is in the crosswalk" in some formal structure. One such formal structure is the propositional calculus. We can represent this sentence in the propositional calculus by calling it the proposition.

$P \equiv$ John is in the crosswalk

The language of the propositional calculus consists of the propositional variables, P, Q, r, \dots , and the logical connectives \sim, \wedge, \vee . The sentences of this language are made up in the following way. The propositions and negations of propositions are sentences, and if P and Q are propositions, then $P \rightarrow Q, P \vee Q$, and $P \wedge Q$ are sentences.

We can consider the propositions of this calculus in terms of a relational structure. Thus "John is in the crosswalk" can be written as the relation

$P \equiv$ in (John, crosswalk)

If we treat this sentence strictly as a proposition, then there is no way of comparing it to related sentences such as:

$Q \equiv$ in (John, intersection)

$R \equiv$ in (John, street)

However, if these sentences are treated as true relations, they can be compared so that the relationships that do exist can be recognized. These relationships may be used advantageously in data organization. For example, the data might be organized into property lists. For the example given above, the property list of John might be:

John

In-crosswalk

"

"

"

The above structures are well-defined and allow a certain amount of deductive capability. Thus, if we are given the above property list, the rule

$(\text{in } (a, b) \wedge \text{in } (b, c) \Rightarrow \text{in } (a, c),$

then the additional relation is

$\text{in } (\text{John}, \text{intersection}).$

This structure is insufficient for natural language systems. This can be demonstrated with the following propositions

$p = \text{“Every boy is a person”}$

and

$q = \text{“John is a boy”}$

Within the propositional calculus it is impossible to deduce that John is a person from p and q . In order to be able to handle this type of deduction we must expand this structure to allow variables to appear in place of objects and allow quantification of these variables. In such a structure p might be represented by

$\text{“}x (\text{is } (x, \text{boy}) (x, \text{person})).$

Then, knowing that

$\text{is } (\text{John}, \text{boy})$

we can deduce

$\text{is } (\text{John}, \text{person}).$

A formal structure that does allow the use of variables ranging over objects and quantification over those variables is the first-order predicate calculus.

The language of the first-order predicate calculus is made up of predicate symbols P, Q, R, \dots , variables x_1, x_2, \dots that range over individuals, constant symbols, function symbols, the quantifiers (for all) and (there exists), and the logical operations \wedge, \vee, \sim . Terms are defined to be:

1. Constants and variables,
2. If $c_1 \dots c_n$ are terms, and f is a function symbol, then $fc_1 \dots c_n$ is a term.

The formulas of this language are made up in the following way:

1. If P is an n -ary predicate and $c_1 \dots c_n$ are terms, then $Pc_1 \dots c_n$ is an atomic formula.
2. If A and B are formulas, then $\sim A, A \wedge B, A \vee B$, and $A \Rightarrow B$ are formulas.
3. If A is a formula and x is a variable, then $\forall xA$ and $\exists xA$ are formulas.
4. Nothing is a formula unless forced to be one by 1, 2, and 3.

To a computer, the sentences of the first-order predicate calculus are represented as LISP expressions in Skolem prenex conjunctive normal form. Thus,

Every boy is a person

would be represented as

$\forall x (\text{is } (x, \text{boy}) \Rightarrow \text{is } (x, \text{person}))$

which in Skolem prenex conjunctive normal form would be

$\forall x (\sim \text{is } (x, \text{boy}) \vee \text{is } (x, \text{person})).$

The corresponding LISP expression is

$(\text{FA } x (\text{NEG IS } (X) (\text{BOY})) (\text{IS } (x) (\text{PERSON}))))$

Even the first-order predicate calculus is an improvement over the propositional and the relational structures; however, it is still not powerful enough to be really useful in a natural language system. The main reason for this is its inability to express relationships between relations and to allow variables to range over relations as well as objects.

For example, suppose it is necessary to put into the first-order structure the sentences

“John crossed the street after the light changed.”

or

“A car must always yield to a pedestrian.”

In the first case, we are unable to put the sentence into the first-order structure because we have a relation, namely *after*, whose arguments, namely *crossed* and *changed*, are forced to be relations rather than some individuals. In the second case, we are faced with the quantification of a variable that ranges over situations, not individuals. That is, the sentence states that for all possible situations, a certain condition holds (i.e., that a car must yield to a pedestrian).

With the development given, one can see that the propositional, relational, and first-order structures have certain inadequacies in representing and manipulating natural language information. In the following section, a high-order structure that overcomes these inadequacies is presented.

A DATA STRUCTURE BASED ON A HIGH-ORDER REPRESENTATION

For the reasons previously stated, we have progressed to a high-order structure for the representation of natural language information. In some cases, the high-order structure is similar to the first-order structure we previously defined. However, it is an extension of that structure in that we now allow relations to be imbedded in other relations and we allow variables to range over these more complex structures. As a consequence, it is possible to represent situations as variables, the relationship between relations, and the modifications of terms. These features permit the representation of a wide range of natural language information. In addition, because of the generality of the structure chosen, the manipulation of information represented is greatly simplified.

A formal definition of this high-order structure is defined within some natural language discourse.

1. a_1 is a *constant* iff a_1 is an object within
2. m_1 is a *basic modifier* iff m_1 is a simple modifier within
3. c_1 is a *modifying marker* iff c_1 indicates the occurrence of a modifier that is not simple

The high-order structure is made up of constant symbols a_1, a_2, \dots , modifier symbols m_1, m_2, \dots , modifying marker symbols c_1, c_2, \dots , function symbols f_1, f_2, \dots , variables that range over constants x_1, x_2, \dots , n-ary relation symbols p_1, p_2, \dots , variables that range over complex structures y_1, y_2, \dots , and the logical symbols $\sim, \wedge, \vee, \Rightarrow$.

Terms are defined to be either:

1. Constant symbols
2. All variables
3. Complex structures that are defined as either
 - a. *modified objects* written $m(a)$, where m is either a modifier or a variable; and a is either a constant, a variable, or a complex structure [the interpretation of $m(a)$ is that m modifies a]. A *modifier* is either a basic modifier, or is of the form $c_1(b)$ where c_1 is a modifying marker and b is a constant or a modified object.
 - b. n-ary relations over the terms q_1, \dots, q_n written (Pq_1, \dots, q_n) where P is either an n-ary relation symbol or a variable that ranges over complex structures

(this is interpreted to mean that q_1, \dots, q_{n-1} and q_n are in the relation P with each other).

4. if $t_1 \dots t_n$ are terms, and f is an n -ary function symbol, then $f(t_1 \dots t_n)$ is a term.

Formulas are defined in the following way:

1. n -ary relations and variables that range over n -ary relations are atomic formulas.
2. If A is an atomic formula and m is a modifier, then $m(a)$ is a formula.
3. If A and B are formulas, then $A \vee B$, $A \wedge B$, $\sim A$, $A \Rightarrow B$ are formulas.
4. If A is a formula and x is any variable, then $\forall x (A)$ and $\exists x (A)$ are formulas.

Internally, the new structure can be considered in certain respects as an extension of the first-order structure. Thus, where only objects appeared in the LISP expressions in the first-order structure, a complex structure may now appear. The sentence "John crossed the street after the light changed" would appear as the LISP expression:

(AFTER (CROSS (JOHN) (STREET)) (CHANGE (LIGHT)))

CONCLUSION

In any high quality natural language question-answering system one must have:

1. an internal data structure sufficiently rich to represent natural language information,
2. a method of transforming natural language into that structure, and
3. a strong deduction algorithm for manipulating the information in that structure.

It should be noted that these are not separate problems. In fact, the data structure plays the central role in such a system for the following two reasons. First, the realization of a transformational algorithm is completely dependent upon the characteristics of the internal structure. Secondly, the deduction algorithm can only be as powerful as the expressiveness of the internal data structure.

In this paper we have discussed the inadequacies of lower-order schemes for the representation of information in natural language systems. A high-order structure for the representation of natural language information was then presented. It has been shown that within this structure a much wider range of natural language information can be represented.

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UNDERSTANDING NATURAL LANGUAGE: SEMANTICS AND THE SEMANTIC CONVERTER

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ABSTRACT

The field of semantics has always been classified as “fuzzy” by linguistics-logicians and philosophers alike. There is little agreement among semanticists where its borders lie or what the terrain looks like. Logicians, philosophers, and linguists all approach it with the tools of their own profession, and the problem of simply defining semantics and “meaning” has occupied volumes of text. This paper describes two ends of a language system, a syntactic parser with the grammar of English and a deductive component with a base knowledge about a particular subject. A semantic theory is developed to fill the gap between the two.

INTRODUCTION

The basis for a theory of semantics included a world of concepts and structures postulated by the linguist in trying to explain linguistic phenomena. These are not a psychological reality, but a formalism in which the linguist can systematically express those aspects of meaning which are relevant to language use. By manipulating structures in this formalism as a part of analyzing sentences in natural language, the theory of semantics can directly deal with problems of relating meaning to parts of the speaker’s and listener’s knowledge that are not mentioned explicitly in the sentence being analyzed.

THE BASIS FOR A THEORY OF SEMANTICS

To connect the syntactic form of the sentence to its meaning, a semantic system is needed which will provide primitive operations relevant to semantic analysis. This includes a language in which we can easily express the meanings of words and syntactic constructions. The system includes mechanisms for setting up simple types of semantic networks, and deductions from those mechanisms are used as a first phase of semantic analysis. For example, the network could include the information that a *block* is a physical object, while a *bloc* is a political object, and the definition of the word *support* could use this information in choosing the correct meanings for the sentences:

“The red block supports the pyramid.”

and

“The red bloc supports Egypt.”

More important, the meaning of a word or construction is also defined in the form of a program to be interpreted in a semantic language. It is this procedural aspect of semantics that is missing in most other theories, which limit themselves to a particular type of network or relational structure. The meaning selected for a word can depend on any aspect of the sentence, the discourse, or the world. In deciding on the meaning of *one* in “pick up the blue one,” a program is needed which can examine past sentences. This program is included as part of the definition of the word *one*.

The semantic system includes a powerful heuristic program for resolving ambiguities and determining the meaning of references in discourse. In almost every sentence, reference is made either explicitly (as with pronouns) or implicitly (as with the word *too*) to objects and concepts not specifically mentioned in that sentence. To interpret these, the program must have at its disposal not only a detailed grammatical analysis (to check for such things as parallel constructions), but also a powerful deductive capacity (to see which reference assignments are logically plausible) and a thorough knowledge of the subject it is discussing (to see which interpretations are reasonable in the current situation).

In order to deal with language in a human way, we must take into account all kinds of discourse knowledge. In addition to remembering the immediately previous sentences for such things as pronoun references, the system must remember what things have been mentioned throughout the discussion, so that a reference to *the car* will mean “the car we mentioned earlier” even if there are several cars in the scene.

In addition, the system must have some knowledge of the way a person will communicate with it. If we ask

“Is there a car on the red cobblestone road?”

or

“What color is it?”

the word *it* refers to the car. But if we had asked

“Is there a red car on the cobblestone road?”

or

“What color is it?”

it must refer to the cobblestone road since we would not ask a question we had answered ourselves in the previous sentence.

REQUIREMENTS FOR A SEMANTIC CONVERTER

If a natural language is to be understood in any nontrivial sense by a computer (i.e., if a computer is to accept English statements and questions, perform syntactic and semantic analyses, answer questions, paraphrase statements, and/or generate statements and questions in English), there must exist some representation of knowledge of the relations that generally hold among events in the world as it is perceived by humans. This representation may be conceived as a cognitive model of some portion of the world. Among world events, there exist symbolic events, such as words and

word strings. The cognitive model, if it is to serve as a basis for understanding natural language, must have the capability of representing these verbal events, the syntactic relations that hold among them, and their mapping onto the cognitive events they stand for. This mapping from symbolic events of a language onto cognitive events defines a semantic system.

This model of cognitive structure contains the following elements--*objects, events, and relations*. An event is defined as either an object or an event-relation $R(E,E)$. An object is the ultimate primitive represented by a labeled point or mode (in a graph representing the structure). A relation can be an object or an event, defined in extension as the set of pairs of events that it connects; intentionally, a relation can be defined by a set of properties such as transitivity, reflexivity, etc., where each property is associated with a rule of deductive inference.

Any perception, fact, or happening, no matter how complex, can be represented as a single event that can be expanded into a nested structure of $R(E,E)$ s. The entire structure of one's knowledge at the cognitive or conceptual level can thus be expressed as a single event.

Meaning, redefined for this section, is the complete set of relations that link an event to other events. Two events are *exactly equivalent* in meaning only if they have exactly the same set of relational connections to exactly the same set of events. From this definition it is obvious that no two nodes of the cognitive structure are likely to have precisely the same meaning. An event is equivalent in meaning to another event if there exists a transformation rule with one event as its left half and the other as its right. The degree of similarity of two events can be measured in terms of the number of relations to other events that they share in common. Two English statements are equivalent in meaning either if their cognitive representation in event structure is identical, or if one can be transformed to the other by a set of meaning-preserving transformations (i.e., inference rules) in the system.

Major requirements of a semantic system for transforming text strings into cognitive structure representation are as follows:

1. To transform strings of (usually) ambiguous or multi-sensed words into relationships of unambiguous nodes with each node representing a correct dictionary sense in context for each word of the string.
2. To make explicit, by bracketing, an underlying relational structure for each acceptable interpretation of the string.
3. To relate each element of the string to anaphoric and discourse-related elements of other elements of the same and related discourses.

Requirements 1 and 2 imply that the end result of a semantic analysis of a string should be one or more structures of cognitive nodes, each structure representing an interpretation that a native speaker would agree is a meaning of the string. Ideally, an interpretation of a sentence should provide as least as many $R(E,E)$ structures as there are base structures in its transformational analysis. It will be seen in the system algorithm described later that this ideal is partially achieved. Requirement 3 insists that a semantic analysis system must extend beyond sentence boundaries and relate an interpretation to the remainder of the discourse. The need for this requirement was stated in the previous section. The present system, however, is still limited to single sentence analysis.

Terms such as *of, on, is, and nick-named* act as syntactic relational terms in analysis. Thus, the syntactic and the $R(E,E)$ structure are simply obtained from our phrase structure grammar.

The base structures underlying adjectival and prepositional modifications are directly represented by such R(E,E)s as Hornet (of (American(Motors))) and automobile (made (in (America))). However, the underlying structures for R(E,E)s containing terms like *nick-named* and *smallest* are left unspecified in the above example.

THE SEMANTIC ANALYSIS PROCEDURE

The procedure for semantic analysis requires two major stages. First, a surface relational structure is obtained by using R(E,E)s whose form is transformationally related to that of the parser rules, but whose content may include either syntactic or semantic elements. More complex transformations are then applied to the resulting surface relational-structure to derive any deep structure desired--in our case, the relational structure of the current cognitive model. Although our procedure derived from a desire for computational economy with some restrictions to psychologically meaningful processes, it is satisfying to discover that the approach is largely consistent with linguistic theory as promulgated by Chomsky (1957), Katz (1964), and others. We will note similarities and contrasts, particularly with regard to Katz (1964).

SEMANTIC ANALYSIS ALGORITHM

The form of the semantic analysis algorithm is that of a generative parsing system that operates on the set of R(E,E)s relevant to the interpretation of a particular sentence. The set of SEFs has been shown to be comparable to a modified phrase structure grammar. The semantic analyzer generates from the relevant subset of this grammar all and only the sentence structures consistent with the ordering of the elements in the sentence to be analyzed. Since the set of R(E,E)s contains semantic elements that distinguish word-senses, the result of the analysis is a bracketed structure of triples whose elements are unique word-senses for each word of the analyzed sentence.

If we consider the sentence
 “Pitchers struck batters”

where

pitcher has the meanings of person and container,
batter has the senses of person and liquid, and
strike has the senses of find, boycott, and hit, then

the sentence offers $2 \times 2 \times 3 = 12$ possible interpretations. With no further context, the semantic analyzer will give these 12, and no analytic semantic system would be expected to find fewer.

By augmenting the context as follows, the number of interpretations is reduced:

“The angry pitcher struck the careless batter.”

If only syntactic rules containing class elements such as noun, verb, adjective, and article were used, there would still remain twelve interpretations of the sentence. But by using semantic classes and rules that restrict their combination, the number of interpretations is in fact reduced to one. We will use this example to show how the algorithm operates.

Figures 1 and 2 illustrate minimal lexical and R(E,E) structures required for analyzing the example sentence. The first operation is to look up the elements of the sentence in the lexicon using the root form logic to replace inflected forms with the normal form plus an indication of the

inflection. Thus, the word *struck* was reduced to *strike* and the inflectional features *Sing (ular)* and *Past* were added to the lexical entry for this usage.

Figure 1. Dictionary Storage

PITCHER	S1	PERSON	N	SING
	S2	CONTAINER	N	"
ANGRY	S3	EMOTION	ADJ	
STRIKE	S4	BOYCOTT	V	SING. PAST
	S5	DISCOVER	V	SING. FAST
	S6	HIT	V	SING. PAST
BATTER	S7	PERSON	N	SING.
	S8	LIQUID	N	SING.
CARELESS	S9	ATTITUDE	ADJ	
THE	S10	ART DEF	ART	

Figure 2. Minimum Lexical Structure

- <N (Adj)>
- <NP VP NF-----Syntactic Event Forms
- <N (ART)>
- <Person mod emotions>
- <Person hit person>
- <Person hit liquid>
- <Person mod attitude>
- <Person hit person>
- <Person discover mineral> -----R(E,E)s
- <Person boycott group>
- <Container hit liquid>

CONCLUSION

In order to program computers to understand natural language, it is necessary to have an explicit and complete notion of semantics. The attempts at writing language understanding programs have made it clear just what a semantic theory has to do, and how it must connect with the syntactic and logical aspects of language. In practical terms, a transducer is needed that can work with syntactic analysis and produce data that is acceptable to our logical deductive theorem-prover.

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DEVELOPMENT OF A HYBRID ADAPTIVE STRUCTURATION THEORY MODEL

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ABSTRACT

The purpose of this paper is to extend the scope of research in the area of emergent organizational structure through the development and definition of a new adaptive structuration/diffusion theoretical model. When new technology is introduced into an organization, it does not occur inconsequentially. The design of the applied technology as well as the design of the organization are interdependent tasks that affect each other in a reciprocal manner.

Structuration models go beyond the surface of organizational behavior to consider the underlying ways in which the impact of technology, upon an organization, materializes. By combining literature streams from both diffusion and adaptive structuration theories, this paper attempts to develop a model that blends both theoretical areas. The framework of the model comes from a modified version of DeSanctis and Poole's 1994 adaptive structuration model. The constructs of the model are defined using Kwon and Zmud's literature review on diffusion theory (1987) along with a simplification of DeSanctis and Poole's original model.

APPLICATION OF MOTIVATION THEORY TO THE CULTURAL ACCEPTANCE OF NEW TECHNOLOGY IN A RURAL MEDICAL CLINIC

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ABSTRACT

This paper applies the Cusp Catastrophe element of Catastrophe theory to the preliminary examination of the roles that motivation and organization culture play in the introduction and acceptance of new technology within a rural Midwest medical clinic. Clinic X is a small but growing clinic with five offices scattered across the Midwest. Although Clinic X's corporate culture had been developed and nurtured by a strong empowering leader who cared about her employees, when faced with a pivotal change to business operations, loyalty to the organization and concern for corporate good disintegrated. This paper examines the impact that the introduction and implementation of a new billing technology package had on individual motivation, organization culture and the organization in general.

INTRODUCTION

Implementation of a new technology package within an organization does not occur as an isolated event. Rather, introduction or preparation for introduction of new technology often triggers a variety of responses both in and outside the organization. One organizational aspect that provides a significant contribution to internal reaction to a technological change is corporate culture. Depending upon the situation and the strength of the corporate culture, this can prove to be either a benefit or a detriment to the organization. While every company has some type of corporate culture, most cultures in successful companies are significantly stronger than their counterparts (Peters, 1980; Peters & Austin, 1985; Peters & Waterman, 1982; Schwartz & Davis, 1981). In a company sporting a strong corporate culture, meaning is shared among and agreed upon by most of its members. However, members often take several corporate aspects for granted and accept that they are normalities of the organization (Deal & Kennedy, 1982).

A strong corporate culture can provide a defining framework for situations and can help its organizational members "make sense" of their current circumstances (Kreps, 1982; Louis, 1983; Weick, 1969). Thus, these shared meanings and values provide members with the ability to informally work through issues and problems on their own (Meyor & Rowan, 1977). This paper furthers the research into sudden "lost meaning" and the application of cusp catastrophe theory through application of the theories to the implementation of a new technology package at a rural medical clinic in the Midwest

SUDDEN LOST MEANING

The underlying concepts behind “sudden lost meaning” focus upon an organization’s shared corporate culture and identity and then their sudden demise (Karathanos et. al., 1995). Specifically, an organization may have a strong corporate culture which lends itself well to defining situational circumstances within the organizational boundaries, however, upon the occurrence of a pivotal situation, that culture and identity is quickly lost by members of the organization (Karathanos et. al., 1995).

In defining “sudden lost meaning”, Karathanos, Pettypool and Troutt (1994) based their theory upon motivational theory and cultural contingency variables. Two of the variables that they examined were motivation and, in turn, high performance level. They also defined motivation as “forces which account for the level of effort expended at work.” Thus, a motivated employee would be expected to extend a higher level of effort at work, and, assumedly, a higher level of performance. Karathanos et. al. posited that due to the correlation between high individual performance and high corporate performance, the forces that instilled these qualities should be incorporated into the organizational culture (1994).

To further define motivation, expectancy theory defines motivation as the multiplicative result of expectancy, instrumentality and valence (Vroom, 1964). “Expectancy” is defined as the individual’s assumption that performance is a result of the effort extended. “Instrumentality” assumes that there is a direct relationship between performance and rewards. “Valence” is associated with the individual’s preference for the offered reward (Karathanos et. al., 1995). Thus, should an individual perform to the best of his/her capabilities and fail to receive a reward equivalent to the supposed effort extended, the individual’s level of motivation would be negated.

Another foundational motivation theory behind “sudden lost meaning” is that of Equity theory (Adams, 1963). This theory proposes that individuals continuously compare the equality of their contributions to the organization and their received rewards. In turn, the individuals also compare their contribution/reward ratio to those of their peers. When the ratios come up lacking in the individual’s perceptions, actions are taken to move closer to a state of equilibrium. Those actions may include decreased work performance through decreased effort or time contribution, a request for increased rewards or compensation or the inequity may possibly serve as justification for personal use of company resources (Karathanos et. al., 1995). On the other hand, it may be possible that the individual finds the value of the reward is higher than the contribution. In that case, the individual may work harder, put in more hours or ask to review the provided contribution.

When inequities are perceived, a conflict develops between the individual’s expected organizational meanings and assumptions and those that the organization actually follows. Both hope and trust in the organization may be negatively affected. (“Hope” is defined as the expectation that what is desired will come to pass while “trust” is the belief in someone’s goodness and integrity.) Thus, the shared meaning and framework that had been established between the employee and the organization regarding performance/reward equity begins to change as may the meaning found by the employee in other areas of the organization (Karathanos et. al, 1995).

CUSP CATASTROPHE THEORY

In 1972, Rene Thom developed the seven element catastrophe theory model examining abrupt change through “fits and starts” (Zeeman, 1976). This theory was developed to model discontinuous sudden changes in a (behavior) variable as the result of small continuous changes in one or more control variables. Thus, catastrophe theory could be used to not only explain sudden changes in certain dependent variables, but it could also help an organization prepare for those changes.

In Karathanos et. al (1995), the authors developed a model illustrating one of the seven elements of Thom’s model, cusp catastrophe. In their model, the authors identified the behavior variable as “identification with the organization’s culture” and the control variables as “trust” in the organization and “hope” that the desired expectations would come to pass (Karathanos et. al., 1995). An individual having high values of trust and hope in the organization identified with the organization’s culture, whereas those with low hope and trust would reject the corporate culture. Those individuals with mixed values of trust and hope could either accept or reject the corporate culture depending upon the situation and its level of importance to that person.

APPLICATION OF THEORY

As technology proliferates our daily lives, medical clinics are finding that they must institute some form of electronic medical billing technology in order to comply with external pressures such as competition, insurance company regulations and Medicare mandates (Hagland, 1998; Straub, 1998). However, as is the case in many organizations, management and employees often view information technologies as a threat to their position in the organization. Massaro (1993) found that the costs of implementing technology in regards to organizational invasion and resources were often greater than expected. In some instances, process problems surfaced that had to be dealt with before actually implementing the technology (Massaro, 1993). Institutions and top management had to be prepared to invest in both human and financial resources to implement the technology (Massaro, 1993).

In this study, the authors researched a rural Midwest medical clinic (Clinic X) that had been in operation for twelve years. The clinic had grown to five locations scattered throughout the region servicing over 35,000 patients. The overall internal structure of the organization was moderately centralized with the billing department manager serving a pivotal role. The structure of the communication network followed a rather informal approach. Responsibilities of the billing department employees were functionally oriented and centered on individually assigned clinics. Although most of the employees had received a basic education, few had sought additional education beyond high school and only one had had experience in medical billing prior to joining the organization.

When the clinic first opened, the billing technology consisted of electronic typewriters and a sophisticated manual filing system. At the time, operations consisted of one facility, three doctors, one billing manager and two billing clerks. Job responsibilities were rather generalized with the billing clerks and billing manager each performing all of the steps in the billing process. A strong, positive rapport existed among billing clerks and the billing department manager. Employees

contributed equally and to the best of their abilities. In turn, the organization compensated each person fairly, and in some cases, better than neighboring clinics. Clinic X's employees as well as their opinions were valued and treated with respect. Each employee's level of responsibility increased as she showed herself capable.

As the practice succeeded and the number of patients continued to grow, the office manager started investigating computerized billing technology in order to increase the productivity of the office without increasing the number of people on payroll. Once the office manager had decided upon a package to purchase, arrangements were made with the software company for purchase and installation of the new hardware and software. On the day before the technology was to be installed, the office manager notified the billing manager and clerks of the upcoming change in processes.

Upon hearing about the unexpected change in their daily operations, the billing department members became angry about their lack of input, awareness and the change in general. When the technology was implemented, there was strong resistance to change and resentment among the billing department staff toward the office manager and the organization. The billing clerks preferred the old familiar system and refused to switch over to the new technology. In order to get the billing clerks to use the new system for billing tasks, the billing manager had to remove access to the old system. Within two weeks of the implementation, both billing clerks had quit the organization. The billing manager was forced to immediately hire and train two replacements for the billing clerk positions. As part of the training, the billing manager had to train the new clerks on the billing technology with which she was barely familiar.

For several weeks, the billing manager resented the new technology and the turmoil it created within her department. In time, she came to appreciate the efficiencies of the new technology and the role it played in helping her to fulfill her duties within the organization. She eventually became a technology advocate seeking ways to use the new system to automate other processes within the organization.

SUMMARY AND CONCLUSIONS

Before the application of a new, process-changing technology, Clinic X's billing department members understood their roles in the organization and felt like they provided a valuable contribution to operations. Although they were not richly rewarded, they felt that they received comparable, if not better, wages than their counterparts at other clinics. With increasing responsibilities and valued service, the billing department employees felt like they understood the desires of the organization and were motivated to perform their jobs to the best of their capabilities.

When faced with a sudden work-life altering change, the employees' level of trust plummeted. Whereas once their input was considered invaluable, they were now left in the dark on a decision that would most affect their daily lives. Their hopes were dashed as they now had to change their daily operations completely and their opinions regarding the matter were of no concern. From the billing clerks' perspective, the organization's culture no longer paralleled their own viewpoints. As a result, the two billing clerks quit and moved on to other medical clinics. Although the billing manager remained, it took several weeks for her to adjust to the new technology, the changes it brought and the role it played in helping her to fulfill her duties within the organization.

Once she realized the efficiencies and effectiveness of the new system, she was able to appreciate the adjustment that had been made to the organization's culture.

Given what happened to Clinic X, had the billing department been included at the beginning of the technology update process as well as throughout, one must question whether or not the same results would have occurred? In future applications of this theory to the technology implementation process, researchers may want to examine information richness and communication levels. There may be a relationship between these factors and the level of motivation and culture acceptance following a technological change. The turning point in this scenario was quite significant. However, there comes a point in daily operations where a small flux may trigger an individual's change in motivation and cultural alignment. It may also be interesting to try to develop a scale for determining motivational and cultural pivotal change.

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SOFTWARE AS A SERVICE

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ABSTRACT

A new trend in software application development is to allow organizations to create software applications by “stitching” together existing applications existing in remote servers. This “service” approach allows for easier software development and maintenance - “Web Services” opens up new opportunities to take advantage of this new approach. Web Services utilizes open standards such as SOAP, and UDDI (Universal Description, Discovery, and Integration), which facilitate data exchange among very different applications. SOAP uses XML (Extended Markup Language) to send commands between applications across the Internet. UDDI defines a universal catalog of Web services, which lets software applications discover and utilize services on the Web.

The purpose of this paper is to study the Web Services standards, and see how they allow software to be treated as a service. The paper will be beneficial to organizational managers, academic researchers and faculty members in the business or information technology discipline. Academicians will be especially interested the Web Services protocols, and in developing new Web Services architectures, while managers will be better equipped to exploit this new technology.

PRODUCTION SCHEDULING PROBLEMS FOR A TOTALLY INTEGRATED CARPET MANUFACTURER: A PRELIMINARY INVESTIGATION

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ABSTRACT

As production systems expand, there is a tendency for the scheduling and control activities to become complex, or at least more demanding with respect to the time required for their performance. Internal pressures exerted by the influence of an enlarging production system often stimulates an evaluation of current methods of production scheduling and control. These internal pressures could result in a loss of control over the production system with possible reverberations in any one or all of the scheduling and control activities. Problems of production scheduling and control usually manifest themselves in deviations from planned courses of action. In order to anticipate system deviations, there is a continuing need to investigate production scheduling and control procedures in light of available analytical methods and quantitative tools of analysis.

INTRODUCTION

The production operations of manufacturing industries can be characterized by successive steps of input, processing, and output. The output of one processing center frequently serves as the input to other processing centers. This sequence continues until the item or unit of production reaches its finished state.

This sequential manufacturing pattern of input, processing, and output takes different forms in varying degrees of complexity. Only one kind of raw material enters some types of systems. The flow of production is then highly systematized and workflow routing problems are minimal. Other production systems may be characterized by different types of inputs and workflow routes, or many different inputs with a standardized workflow routing, such as assembly line processing. Between and within the different types of processing systems, there may be unique system attributes which combine and interrelate themselves to form a *hybrid* type system.

STATEMENT OF THE PROBLEM

Scheduling a processing unit is one of the most complex problems facing mill management. The complexity arises from the fact that production scheduling problems are interrelated with other

operational aspects of the production system. Scheduling decisions affect machine utilization, employment, productivity, and inventories.

This preliminary study concentrates on the effectual relationship between scheduling and in-process inventories. An attempt has been made to show that scheduling decisions can affect in-process inventory levels to a considerable extent. Furthermore, if decision rules which can efficiently and effectively reduce levels of in-process inventories can be identified, it is then possible to reduce the investment in inventory. The amount of the reduction depends upon the efficiency of the decision rule in spreading the *gap* between *normal* inventory levels and those levels obtained through implementation of the specified decision rule.

Uncertainty is inherent within most production-inventory systems. Processing orders are subject to change, processing times may fluctuate, or machine breakdowns may occur at random intervals and may take varying amounts of time to repair. Such potentially uncertain events tend to preclude the use of deterministic models since the variation associated with the above mentioned events may not *fit* a recognizable deterministic model.

This paper is a preliminary analysis of the relationships and effects of designated scheduling policies within the yarn-producing segment of a large, totally integrated carpet manufacturer. Orders are produced according to customer specification, and each order is composed of yarns that are processed into one to 40 colors. The proper size batch of yarn is dyed to specifications and finally batches are assembled into a carpet. The problem relates to the study of the behavior of in-process inventory levels under experimentally controlled conditions. The problem has been examined from a relatively short-run point of view, such that certain conditions can be considered as fixed; for example, a fixed number of orders and previously established plant technological capabilities.

The carpet textile industry, and especially a totally integrated carpet firm that manufactures the product from basic raw material to the completion of the final rug, presents some interesting and complex problems in production scheduling. In the carpet industry, the production characteristics are such that the production system falls somewhere between the general flow-type industry and the batch-type manufacturer.

OBJECTIVE

This paper is designed to outline a study to examine the effects of alternative scheduling policies on levels of in-process inventory within an established production system. An assumption has been made that there are alternatives available for scheduling a block of orders and that some of these alternative schedule plans are *better* than others relative to an expressed measure of effectiveness, i.e., minimizing in-process inventories.

Different scheduling policies should have varied effects on inventory levels and receiving times of orders in the process of production. If there are a great number of alternative policies, some of these policies should be significantly different from others relative to the effects on in-process inventory levels. An attempt has been made, therefore, to compare and contrast the effects of selected scheduling rules on the levels of in-process inventories. An additional purpose of the study is to indicate the nature of some aspects of production scheduling problems and observe the

effectiveness of statistical analysis, in conjunction with simulation procedures, for solving some of the types of scheduling problems found within the yarn producing segment of the carpet industry.

GENERAL METHODOLOGY

The methods of inquiry should be directly related to and determined by the nature of the problem. Many problems in the general area of production management are amenable to analysis and solution through the use of models, which represent, in some fashion, the important characteristics of the situation under study. A representative model of a production scheduling system, when verified, may become an important vehicle for analyzing aspects of the scheduling system, particularly with reference to movements in inventory levels. The above statement should be true of models in general (Peach, 1963).

Scheduling problems are not too difficult when demand is certain, process times are constant, and the items being manufactured are highly standardized. However, if demand is uncertain, processing times are variable, and many non-standard items are produced, the scheduling problem becomes more complex.

Plant studies were utilized as the method for obtaining information about the (general) nature of production scheduling problems. Three batch-type processors were interviewed: a job-shop batch processor in the metal working industry, a tire manufacturer, and a totally integrated carpet manufacturer. Each firm presented interesting and challenging problems of production scheduling. The carpet manufacturer was selected for several reasons: access to informational needs, access to actual data to “run” through the model, and, foremost, a personal interest in studying actual production scheduling problems in this type industry and seeking new ways of analyzing and/or solving some past and current scheduling problems.

When feasible and appropriate, it is usually best and perhaps easiest to use an objective, deterministic model of the activity under study. However, if an objective, deterministic quantification of system characteristics and parameters is in contrast to realistic descriptions of the situation, the results will be invalid and/or unreliable. Objective results are desirable, but frequently unobtainable if a problem’s characteristics cannot be defined and/or represented by available analytical models. The use of analytical models for solving scheduling and dispatching problems involving several machines and several alternative products has been limited. When the deterministic model is modified in order to allow for the possible fluctuation of variable factors, the model may be cast as a probabilistic one. It has been pointed out that scheduling problems are dynamic and that situations in which relevant parameters remain constant are rare (Eilon, 1962).

Simulation, as a problem solving methodology, attempts to overcome some of the obstacles connected with analytical methods, e.g., obstacles often encountered when attempting to associate observed activity with a recognizable deterministic model. The results of several laboratory experiments on simulation problems and procedures have been operationally verified and subsequent reporting indicates that simulation procedures show good results in reducing costs of manufacturing and/or processing time (Sisson, 1961). The production scheduling system studied has been analyzed and described according to the processing and scheduling characteristics that define or explain the framework of the problem area. A computer model was built that represented

the basic processing characteristics including processing times, move times, and other important production system attributes.

CONCLUSION

An increasing utilization of the electronic computer has facilitated research in industrial situations. It is possible to represent systems symbolically and simulate the activity being studied. Once the model has been built, the computer can rapidly evaluate the possible results of alternative courses of action--alternatives that possibly could not be evaluated except by the experimental method of simulation

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A FACTORY APPLICATION FOR MODELS AND PRODUCTION SCHEDULING

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ABSTRACT

Scheduling problems, by their very nature, are complex and dynamic. The complexities arise, in part, from the need to recognize the many interrelationships that typically exist in scheduling problems. Even small scale scheduling problems may become complex if there is an attempt to account for the pertinent variables and the many possible routings of orders and parts of orders. Efforts to somehow overcome the complexity arising from the interrelationships that exist in most production management problems frequently take the form of "sub-optimization," or concentrating on optimizing a defined segment within the total operational framework.

INTRODUCTION

Before discussing the factory model characteristics that form the basis for this paper, a brief examination of the general framework of production scheduling problems will be made. The general framework will include a definitional clarification of the scheduling process and will point out some of the attempts to solve the scheduling-sequencing type problem through the use of models.

THE NATURE OF PRODUCTION SCHEDULING

Production scheduling is a unifying problem closely related to other areas within an organization such as sales, cost control, purchasing, capital budgeting, and inventory management (Pounds, 1961). Of particular interest relative to this paper is the relationship between levels of inventory and production scheduling. Magee (1956) emphasizes the interrelationships between these two important production management activities. Irrespective of the organizational status, it is generally recognized that production scheduling and inventory management, or control, are closely interrelated. In theory, problems are frequently classified according to types [of problems], e.g., distribution, allocation, queuing, or sequencing. However, real industrial problems often do not fit into rigid categories (Ackoff, 1956).

THE MEANING OF SCHEDULING

Scheduling is the establishment of starting and finishing dates for productive activities (Rago, 1963). Under certain conditions, scheduling may also determine the sequence of operations and/or the assigned workload on certain equipment. For example, as the size of the scheduling matrix increases (i.e., more orders to be assigned to a larger array of machines) the number of possible combinations of routings increases exponentially (Giffler, Thompson & Van Ness, 1963). However, the accomplishment of the scheduling function should not generally imply that rank orders have been set or specific machine loads determined.

The term *scheduling* is often used to describe the sequencing situation. Scheduling should be reserved for procedures which give the time of arrivals of units requiring service (Sisson, 1961).

Sequencing is defined as determining the order in which items are processed. The scheduling of complex activities, particularly when job-process times are short, does not explicitly determine the order of work for manufactured items. Scheduling-sequencing problems are, therefore, concerned with determining both the *time* that the order processing is completed and the *rank order*, i.e., the sequence of order processing.

THE INDETERMINATE NATURE OF SCHEDULING PROBLEMS

A problem is said to be *indeterminate* if the various factors and restraints that describe the problem do not indicate that an optimum solution can be derived. In general, procedures for solving indeterminate problems generate a set of feasible solutions rather than pointing out a single *best* solution (Giffler, 1963). A determinate model, on the other hand, takes into account only factors assumed to be exact or *determinate* numerical values.

It is recognized that “there are many phenomena in which the cause mechanisms are so complex that it is futile to attempt to set up a deterministic model” (Lindgren & McElrath, 1959). Many industrial problems, due to inherent complexities, preclude attempts to quantify factors with exact mathematical expressions of existing relationships. Although many real industrial problems are indeterminate, this should not detract from their importance, but stimulate continued efforts to solve them.

Scheduling and dispatching problems are frequently classified as indeterminate due to an inability to precisely represent the important and interrelated scheduling factors. Indeterminate problems may be solved, however, and a *good* answer derived, through the use of simulation, by testing certain decision rules that effectively narrow down the searching activity. Indeterminate scheduling problems are frequently combinatorial problems with a great number of possible or feasible answers. In a combinatorial scheduling type problem there may be many orders to be assigned to several prospective machines; it is not uncommon to have millions of possible schedule alignments. Several studies have been made with special reference to job-shop scheduling problems, in which the algorithmic and analytical procedures used were reported. These procedures usually seek solutions to the indeterminate type problem by utilizing a step-by-step iterative procedure that converges upon an optimum solution (Johnson, 1954; Giffler, Thompson & Van Ness, 1963; Sisson, 1961).

THE USE OF MODELS IN PRODUCTION SCHEDULING

One primary function of management is to make decisions from among various alternatives and attempt to project the consequences of their choices. Unless the many factors that enter into and affect the decision can be explicitly stated (and even in some instances where explicit criteria are available), the projection of consequences poses a threat to the decision-maker. A way to choose among alternatives is needed, and models help fill this need. Without models to predict and forecast probable results, confidence in decisions must decline (Buffa, 1961).

Models have been described as abstractions of real life things or processes (Buffa, 1961) or as a “representation of reality that attempts to explain the behavior of some aspect of it” (Miller & Starr, 1960). The second definition indicates not only what a model is but also what a model does. Models have long been used by the physical scientist in his or her attempt to duplicate the phenomena with which he works. The transition period from the physical scientist’s use of models to the management scientist’s use of models was quite lengthy.

In the past, scheduling systems have been framed primarily as schematic models, using Gantt charts or some adaptation of these in diagrammatical form. The Gantt chart and other schematic models can be very useful for master scheduling, and for scheduling orders or parts for orders, when there are few component parts to schedule and control. However, as the scheduling problem becomes more complex, with additional variables and a multitude of parts to schedule and assign to machines, the Gantt chart becomes less effective (Chorafas, 1958).

Though the term *models* may imply something physical or tangible, this need not be the case. An important category of models is the quantitative or mathematical model. Because mathematics is a precise language it is usually advantageous to describe and represent a problem by a mathematical model. If none of the generally accepted mathematical models can properly represent the problem, then simulation, based on distributions developed from empirical evidence, may be the only means for deriving a satisfactory solution. The inability to analytically frame the typical scheduling-sequencing problem has been pointed out by Rowe (1960): “There is no known distribution for the scheduling type combinatorial problem.”

General problem characteristics might suggest a simulation problem-solving approach, for example, if the problem has a *large* number of variables to contend with, as is the case in many industrial situations, or if quantitative measurements of the variable factors do not fall into any identifiable or predictable pattern.

The characteristics of production in a carpet factory indicate that a simulated approach would be most appropriate. There are many variables to be included in the symbolic models, e.g., variable processing times, variable length waiting lines, irregular machine breakdowns, and varying numbers of order rejections.

SIMULATED EXPERIMENTATION

The previous two sections indicated that simulation is a model building process that can aid the decision-maker in solving complex problems when direct analytical techniques fail. In this section, the experimental nature and purpose of simulation models will be examined, with special reference to the use of decision rules. A decision rule is “any method which from time to time

provides an explicit way for selecting one action from a set of alternative actions available to the decision" (Churchman, 1961).

Once a model has been built that adequately describes the system under study, experimentation via the model becomes possible, even though a model is seldom an exact image of the operation or actual system. The level of detail in system representation that is adequate is a variable itself, primarily dependent upon model purpose. Therefore, prior to actually running the simulation model, the researcher should be satisfied that the model represents, to some established degree, the actual system studied.

DESCRIPTION OF THE COMPUTER MODEL

The computer model developed is a symbolic digital representation of the production processes necessary to convert raw wool or synthetic fiber into a finished yarn. The model is designed to represent the activity of processing yarn through the consecutive production stages of blending, dyeing, carding, spinning, twisting, and winding. Each production department exhibits different processing times that are determined primarily by the technological capabilities of the production equipment. Within the model, individual order processing times are considered to be a function of three primary variable factors:

- (1) Queuing state of the processor (backlog)
- (2) Quantity of the item to be processed
- (3) Perturbations caused by recognizable and non-recognizable influences.

The convention adopted is to test, for each time interval, the availability of a processor, i.e., a dye machine, blender, carder, twister, or winder. Implicitly, this periodic check evaluates the state of the system with regard to point one above, or asking whether there is a machine with higher priority orders waiting. A cycling routine is utilized which checks each processing facility for each time interval; loading and processing the color *next in line* as determined by a specified dispatching rule for order processing. The actual processing time is calculated at the point in simulated time when the next order is available and the necessary machine is free. Processing times in certain departments are based on quantity to be processed, while times in other areas are based on empirical distributions of processing times. *Perturbations* are random events, such as rejection of a color during processing, machine breakdowns, or order rejection.

CONCLUSION

Computer realization of this aspect of the model is based on the maintenance of files, which are composed of order data held in varying stages of production as a movement of orders is made through simulated time. The original order alignment at the initial process of dyeing determines the general nature of priorities for each subsequent department. It is assumed that the policy of the specific decision rule being tested is followed in all subsequent processing departments, and this assumption is often the case in reality, when interdepartmental processing capabilities are closely coordinated and well synchronized. For example, if first come-first serve is the decision rule being tested, with the implementation of this rule at the first process (dyeing), the same rule will be followed in subsequent processes.

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