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EXPERIMENTAL INVESTIGATION OF THE IMPACT OF LINEAR AND NONLINEAR INFORMATION PRESENTATION ON PROBLEM SOLVING

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ABSTRACT

Traditional methods of information presentation rely on linear or sequential media (e.g., textbooks, sequential databases and lectures). Linear text presentation is organized and designed to be accessed or presented in a fixed sequential order as in printed materials. Linearity of media is not a problem when the subject matter being presented is well structured and fairly simple (Spiro and Jehng 1990). However, as content becomes more complex and less structured, increasingly greater amounts of relevant information are lost with linear information presentation (Spiro and Jehng 1990).

Some researchers argue that computer-based linear approaches well match human understanding of knowledge presentation and learning (Schank and Abelson 1977). Other researchers argue that non-linear links match the way people think (Bush 1945; Shneiderman 1989). Studies of human information processing indicate that linear text organization in databases do not match data organization in users' minds (Landauer, et al. 1982). According to cognitive psychology literature, nonlinear links to information overcome the problems identified in linear text research. There is also substantial evidence that matching information presentation (or problem representation) directly to the problem task has significant effects on problem-solving or decision-making performance (Bettman and Zins 1979; Vessey 1991). These studies show that problem-solvers or decision-makers perform better when information presentation matches the task to be performed.

This study investigates the match of technology (in this case, mode of information presentation) to problem task and the relative importance of each to problem-solving performance. In this research, this was achieved by matching information presentation (linear and nonlinear) to problem tasks (spatial and symbolic). The specific focus is on problem-solving performance in relation to linear and nonlinear information presentation and access. It also examines which combination of problem task type and information presentation yield the best problem-solving performance.

In a laboratory setting, an executive information system was used as the tool to conduct this experiment. The experiment used graduate business students in a two-factor repeated-measures design employing a multivariate analysis of variance to analyze the data. Repeated measures were conducted to analyze the experimental group under each treatment (linear and nonlinear). Preliminary findings from the study support the proposition that nonlinear information presentation and access was superior and significantly higher than the linear problem-solving performance.

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ADDRESSING THE PRODUCTIVITY PARADOX: THE NEED FOR A PSYCHOPHYSIOLOGICAL PERSPECTIVE

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ABSTRACT

In this paper, we argue that the "Psychophysiological Perspective" has a valuable contribution to make to our understanding of the impact of new technology on individual and organizational performance. In essence, the psychophysiological perspective views the human agent as a "multi-component, multi-modal system" made up of interacting physiological, behavioral and experiential subsystems (Gale and Christie 1987). By triangulating these three dimensions, psychophysiology has the potential to yield a much richer account of the dynamics of user interaction with complex technologies than conventional approaches. Although psycho-physiological investigations are something of a rarity, there are encouraging studies in the literature where psychophysiology has provided critical diagnostic insights; for example, in situations where paradoxical decrements in performance have ensued following the introduction of new systems (e.g., Brown, Wastell and Copeman 1982; Wastell 1990).

In the present paper, we describe a longitudinal psychophysiological field study of the introduction of a computerized command and control system in the Greater Manchester Ambulance Service.The study involves the collection of a battery of behavioral, physiological and subjective metrics before, during and after implementation. The baseline phase is now complete and some preliminary analyses have been performed. Although an audit of job satisfaction and occupational stress has indicated some areas of concern, job performance itself is high when judged against prescribed criteria. From a psychophysiological point of view, some striking relationships between performance indices, physiological state and external work demands have been demonstrated: blood pressure and heart rate, for instance, were found to be significantly elevated under conditions of high workload. Having this broad base of psychophysiological measures in place will enable a comprehensive assessment of the impact of the new system and will be of particular forensic value if adverse reactions occur.

The psychophysiological approach provides a broad, multi-level perspective on the process of information systems development (ISD). Psychophysiology views the human subject as a complex whole; psychological factors such as well-being and motivation are central concerns. In this sense, there are clear relationships between the psychophysiological approach and IS design philosophies such as sociotechnical systems design (Mumford and Weir 1979). We believe that psychophysiology has considerable potential in IS research. We are particularly interested, for instance, in the issue of stress in ISD as we have argued that the "stress perspective" can shed revealing light on the behavioral dynamics of ISD (Wastell and Newman 1993). Psychophysiology provides a conceptual framework and a set of techniques which allow the issue of stress to be addressed in a rigorous and objective way.

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HUMAN FACTORS EXPERIMENT UPON LEARNING SQL: AN EVALUATION OF THE ROLES OF CONCEPTUAL MODEL AND COMPUTER INTERFACE

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ABSTRACT

Since SQL has been accepted as an ANSI standard, how to help SQL users to learn and use the language becomes an important issue for both vendors and training providers. At the same time, with the growing concern for making DBMS easier to learn and use, the vendors have also used tabular interfaces in their product, such as QBE-like language. Tabular interfaces use two dimensional table-like qualities of relational systems as an aid in query writing. This trend has led to an interesting research question: "When user training is conducted, will this tabular-like interface help users to learn and use SQL?" Assimilation Theory suggests that meaningful learning can occur only if all three conditions, Reception, Availability and Assimilation, are met (Davis and Bostrom 1993). This theory provides a basis for understanding why a given type of interface may be more effective than another in training. It also suggests that in order to achieve meaningful learning, the cues must be provided to help learners to retrieve appropriate existing concepts.

In an end-user computing environment, it is important that a designer or trainer of the DBMS query language can formulate an appropriate conceptual model (appropriate in the sense of being accurate, consistent, and complete) to ensure that individuals learn to use the language effectively. Each operation of SQL takes either one or more relations (tables) as its operand(s) and produces a new relation (table) as its result. Reisner (1971) developed a syntactic model of query writing from English questions. This model characterizes a query as consisting of a syntactic form, or template, together with the lexical items inserted into it. Both the template and the lexical items are created by a human process which transforms an English sentence into the relevant query components. To be able to identify characteristics that are important for conceptual models provided in a query language manual with different interfaces upon learning and using SQL in a query writing task, the present experiment attempts to test two hypotheses: (1) Will a table model better prepare users to deal with problems that may occur in query writing than a syntactic model? (2) Will it help users learn the language when a given model is consistent with the form of interface?

This research adopted a framework based on Bostrom's end-user training model (Bostrom, Olfman and Sein 1990) but focusing only on the influences of the target system and training approaches on training outcomes. It defines the target system based on two interface types and training approaches based on two conceptual models. A laboratory experiment was conducted to analyze the effect of two types of interfaces (a command based interface with traditional linear syntax and a table-like interface) and two conceptual models through training (syntactic model and table model). User performance was measured through hands-on use of a relational DBMS.

The preliminary results of this research suggest that using different conceptual models may not lead to a difference in user performance, but using conceptual models in conjunction with the consistent form of interface can lead to a difference in user performance. The table manipulation description with support of tabular interface yields user learning and using SQL.

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DECOMPOSITION AND MEANING: A THEORY AND EMPIRICAL TEST

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ABSTRACT

A decomposition is a structure that humans impose upon some real-world phenomenon to better understand it. In the computer science and information systems field, decompositions have had longstanding use as a means of mitigating problems associated with complex analysis, design, and programming work. A "good" decomposition, for example, facilitates analysts' understanding of real-world systems they must model and programmers' understanding of source code they must maintain.

Our understanding of decompositions reflects the classic theory-practice schism described by Carroll (1991). Through extensive experience, we have a strong sense of why decompositions are important and what design principles should be followed to achieve a good decomposition. Unfortunately, we lack rigorous theories that precisely explain the nature of decompositions, the criteria by which they should be evaluated, and the characteristics of good decompositions. As Carroll (pp. 1-2) points out, unless we can understand practice and codify our understanding, we cannot effectively support our knowledge in new and diverse situations, nor can we effectively teach our knowledge to others nor improve it.

In an attempt to establish the foundations for a theory of decomposition, Wand and Weber 1991) have proposed a set of constructs they believe are needed if the nature of decompositions is to be enunciated clearly. Moreover, they have then sought to use these constructs to articulate the characteristics of decompositions they believe convey maximum meaning about the real-world phenomena they structure (Wand and Weber 1992). Specifically, Wand and Weber examine three characteristics: (a) minimality — subsystems in the decomposition must have no redundant state variables; (b) determinism — the subsequent state of a subsystem must be fully determined by its current state and not the state of other subsystems in the decomposition; and (c) losslessness — the relationships between emergent state variables and hereditary state variables must be preserved in the decomposition.

The current research uses Collins and Quillian's (1969) theory of semantic networks and Anderson and Pirolli's (1984) theory of spreading activation to show why decompositions that possess these three characteristics should be better able to communicate meaning about the real-world phenomena they structure. In addition, the current research uses these theories to show why a fourth, widely-accepted characteristic of good decompositions is desirable — namely, the characteristic of minimum coupling whereby each subsystem in a decomposition should have few links with other subsystems in the decomposition.

If decompositions do not possess these four characteristics, it is predicted that users of the decompositions will experience higher response latency and a higher number of errors when they are asked questions about the meaning of the real-world phenomena embodied in the decompositions.

To test this proposition, a laboratory experiment is being conducted. Upper undergraduate and postgraduate computer science students are studying the source code of a computer program that plays a little-known card game. Four versions of the code have been written. One complies with all four good-decomposition characteristics. The other three have a violation of the minimality characteristic, the determinism characteristic, or the minimum coupling characteristic. The losslessness characteristic has not been investigated in the research because it is still not clear how a violation of this characteristic can be implemented in a program in a straightforward way.

After students have studied the version of the program to which they have been assigned, they are asked questions about the meaning of the card game that the program plays. The accuracy of their responses is assessed and the time taken for them to respond to each question is measured.

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DIMENSIONS OF INFORMATION SYSTEMS OUTSOURCING

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ABSTRACT

Outsourcing has emerged as a key method of managing Information Systems especially since the report about Eastman Kodak and IBM's outsourcing partnership in 1989 (Loh and Venkatraman 1992b). However, firms have used outside vendors in many different ways (Gantz 1990) so much so that some IS managers believe that any type of involvement of third party vendors can be considered to be outsourcing. Requirements for outsourcing are not uniform and managers have different evaluations and different approaches to the process (Venkatesan 1992; Welch and Nayak 1992; Walker 1988). Motivations for outsourcing are diverse and vary widely across firms.

The diverse types of outsourcing can not be fully conceptualized simply by one measurement such as the degree of outsourcing which is represented as dollar amounts or as a percentage of total IS budget (Loh and Venkatraman 1992a, Harrigan 1985, 1986). Outsourcing is not a simple substitution of in-house operations. In order to provide a formal framework for outsourcing phenomena, a study of ten sample firms that have diverse sizes and varying patterns of outsourcing contracts in the Northeastern United States was performed. Our case studies and analysis of trade literature on outsourcing allows us to propose two dimensions of outsourcing, *the extent of involvement by outside vendors* and *the strategic impact of IS (Information Systems) applications* based on two criteria of differentiability and comprehensiveness (Nam et al. 1994).

The extent of involvement by outside vendors is defined as the degree of physical substitution of in-house activities by outside vendors. Therefore, this dimension refers to how much internal IS functions are substituted by outside vendors. The strategic impact of IS applications refers to the characteristics of IS applications that client firms outsource in terms of their competitive advantages. Therefore, the second dimension refers to whether IS functions are "operation-oriented" or "strategy-oriented" (Phalen 1992).

In order to identify the factors that affect two dimensions of outsourcing, transaction cost economics (TCE) theory (Milgrom and Roberts 1992; Williamson 1979, 1987) and inertial theory (Hannan and Freeman 1977, 1984) are used. The TCE factors, asset specificity, uncertainty, duration of relationship, and difficulty of measurement, are considered. Inertial theory assumes that organizations rarely make fundamental changes successfully and are subject to inertial forces. Based on inertial theory, three inertial forces, the size of firm, the age of computing experience, and the IT maturity, are considered.

Preliminary results based on the case studies are generally consistent with TCE theory and inertial theory. For instance, one company considered outsourcing for its data center. The company decided to insource after an in-depth analysis of outsourcing. Asset specificity, uncertainty, and difficulty of measurement in the company were relatively high while the duration of relationship was low. This company had relatively high inertial factors.

Further detailed results will be confirmed by a future survey study. The future study will also include other factors, such as the power of IS departments and top management support.

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