

DISSERTATIONS

ABSTRACTS OF INTEREST

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AN UMI Order No. ADG91-35614
AU JONG, HEE-SEN
TI THE SUBGOAL STRUCTURE
AS A COGNITIVE CONTROL
MECHANISM IN A HUMAN-
COMPUTER INTERACTION
FRAMEWORK
IN The University of Michigan Ph.D.
1991, 205 pages
SO DAI V52(07), SecB, pp3712.
DE Computer Science. Psychology,
Behavioral.

Human-Computer Interaction (HCI) research has gained prominence due to the need to make computers easier to learn and use. This research (a) develops a HCI framework to structure and review HCI models, (b) develops a subgoal theory that investigates some pieces missing from current models, and (c) tests the subgoal theory.

This HCI framework combines the Action Theory (Norman, 1986) and the SRK Framework (Rasmussen, 1976) to describe the seven stages of HCI activities and the underlying cognitive processes. These activities are classified as knowledge-based, rule-based, or skill-based behaviors, and they are associated with different cognitive controls, stimuli, and errors. This framework clarifies differences in behavior, states hypotheses for investigation, and structures HCI models. A review of the current models reveals that they seldom address knowledge-based behavior.

This research models knowledge-based HCI activities by investigating the subgoal structure as a cognitive control mechanism to overcome bad interfaces. Users employ extra subgoals both when the task and interface operate on different objects, and when they require a different action sequence for task completion. The bottlenecks in HCI arise from the planning, monitoring, and validating of these extra subgoals.

This research concludes with two studies to demonstrate the subgoal theory's explanatory power. In the formula editor study, subjects used a linear editor and a semantic editor to key in formulas. The linear editor operates on character strings and the semantic editor operates on formula structures. Subjects using the linear editor needed many extra subgoals to translate the mismatched structures, resulting in longer key-stroke time, extra keystrokes, and higher error rate.

In the Lotus menu traversal experiment, subjects saw one of two menu organizations and received one of two instruction formats to execute simple spreadsheet tasks. The original Lotus menu was redesigned to have a consistent structure. Subjects using this new menu could form consistent subgoal structures to explore the menu. Task instruction formats were also manipulated to either match or mismatch the designed menu structure. Subjects given the new menu with the matching instructions had the best per-

formance as they did not need extra subgoals to buffer the out-of-sequence task actions.

AN UMI Order No. ADG92-01094
AU KEH, HUAN-CHAO
TI COMPREHENSIVE SUPPORT
FOR DEVELOPING GRAPHICAL,
HIGHLY INTERACTIVE
USER INTERFACE SYSTEMS
IN Oregon State University Ph.D.
1991, 180 pages.
SO DAI V52(07), SecB, pp3712.
DE Computer Science.

The general problem of application development of interactive GUI applications has been addressed by toolkits, libraries, user interface management systems, and more recently domain-specific application frameworks. However, the most sophisticated solution offered by frameworks still lacks a number of features which are addressed by this research: (1) Limited functionality--the framework does little to help the developer implement the application's functionality. (2) Weak model of the application--the framework does not incorporate a strong model of the overall architecture of the application program. (3) Representation of control sequences is difficult to understand, edit, and reuse--higher-level, direct-manipulation tools are needed.

We address these problems with a new framework design called Oregon Speedcode

Universe version 3.0 (OSU v3.0) which is shown, by demonstration, to overcome the limitations above: (1) Functionality is provided by a rich set of built-in functions organized as a class hierarchy. (2) A strong model is provided by OSU v3.0 in the form of a modified MVC paradigm, and a Petri net based sequencing language which together form the architectural structure of all applications produced by OSU v3.0. (3) Representation of control sequences is easily constructed within OSU v3.0 using a Petri net editor, and other direct manipulation tools built on top of the framework.

In addition: (1) Applications developed in OSU v3.0 are partially portable because the framework can be moved to another platform, and applications are dependent on the class hierarchy of OSU v3.0 rather than the operating system of a particular platform. (2) The functionality of OSU v3.0 is extendable through addition of classes, subclassing, and overriding of existing methods.

The main contribution of this research is in the design of an application framework that uses Petri nets as the computational model of data processing in the synthesized application. OSU v3.0 is the first framework to formalize sequencing, and to show that complex GUI applications can indeed be quickly and reliably produced from such a framework.

AN UMI Order No. ADG91-36662
AU LIN, CHENG-AN ANDREW
TI LINEAR APPROACH VS. NON-
LINEAR APPROACH IN COM-
PUTER-BASED INSTRU-
TION: AN EMPIRICAL STUDY
OF NETWORK BRANCHING
IN HYPERTEXT APPLICA-
TION

IN University of Illinois at Urbana-
Champaign Ph.D. 1991, 191
pages.

SO DAI V52(07), SecA, pp2391.
DE Education, Curriculum and
Instruction. Education, Technol-
ogy.

This study examined (a) the effectiveness of a hypertext network branching approach vs. a linear sequential approach in computer-based instruction and (b) the effects of learner control in a new hypertext learning environment. Sixty subjects were randomly and evenly assigned to one of three treatment groups. Group 1 took the linear MicroSoft Word tutorial. Groups 2 and 3 took a hypertext MicroSoft Word tutorial. The difference between Groups 2 and 3 was in their familiarity to the network branching capabilities of the hypertext environment.

Group 3 was guaranteed such familiarity by 10 minutes of instruction prior to the tutorial learning. Group 2 was not. The learning results were indicated by subject's performance (test scores and test completion time) in an immediate follow-up test and a retention test a week later. Subject's attitudes toward learning were evaluated through an attitude scale obtained from each subject after tutorial learning.

Results indicate that hypertext network branching instruction is better than linear sequential instruction in knowledge learning and knowledge retention if learners of the former instructional system know how the system works. Learners' familiarity with the hypertext system used to deliver instruction is vital to the success of a hypertext network branching approach. A hypertext learning environment does provide a different and interesting perspective on learner control. Learner control will lead to better knowledge learning and knowledge retention than control imposed by the lesson author when learners' needs for learning control are met by more control capabilities in network branching instruction and when learners know how to use these control capabilities. However, learners of network branching instruction do not necessarily show a better learning attitude and a higher learning motivation than learners of linear sequential instruction no matter whether the former are familiar with the instructional delivery system or not.

AN UMI Order No. ADG91-28399
AU WILBURN, HUBERT RALPH.
TI AN INVESTIGATION OF
INTERACTION AMONG
LEARNING STYLES AND
COMPUTER-ASSISTED
INSTRUCTION WITH SYN-
THETIC SPEECH

IN The University of Texas at Austin
Ph.D. 1991, 163 pages.

SO DAI V52(07), SecA, pp2398.
DE Education, Curriculum and
Instruction. Education, Technol-
ogy.

This experimental study investigated the relationship(s) among individual preferred perceptual learning style and the treatment variables of computer-assisted instruction with and without computer-generated synthetic speech.

The Productivity Environmental Preference Survey (PEPS) (Dunn, Dunn & Price, 1981) was administered to 154 students enrolled in education courses at the University of Texas at Austin. On the basis of the PEPS, the participants were identified and

stratified into groups according to their preferred perceptual learning style (auditory, visual or no preference).

The participants were randomly assigned to one of two treatments (computer-assisted instruction or computer-assisted instruction with synthetic speech). The instructional material was programmed in HyperCard. Digitized speech was added to treatment two with the MacRecorder, and the treatments were delivered on Macintosh II computers.

Although statistical analysis revealed no significant interaction between preferred learning style (auditory, visual, no preference) and presentation mode (CAI and CAI with synthetic speech), it appeared that different presentation modes affected learners differently. Participants in each of the three groups receiving CAI with synthetic speech scored higher on the posttest than those participants receiving CAI without synthetic speech. Auditory learners receiving CAI with synthetic speech scored significantly higher ($p < .05$) on the posttest than auditory learners receiving CAI without synthetic speech.

Different learners responded to the addition of synthetic speech differently. Those learners with an auditory preference rated the helpfulness of the voice much higher than learners with other learning preferences. All learners receiving CAI with synthetic speech rated the understandability of the digitized voice near perfect.

The general conclusion is that the addition of computer-generated synthetic speech to CAI could significantly increase learning of certain learners. Further, the addition of synthetic speech to CAI does not appear to be detrimental to the learning of any participants regardless of preferred perceptual learning style.

AN UMI Order No. ADG92-00443
AU GORDON, MARGARET BER-
CHIE

TI A QUANTITATIVE ANALYSIS
OF THE RELATIONSHIP
BETWEEN COMPUTER
GRAPHICS AND MATHEMAT-
ICS ACHIEVEMENT AND
PROBLEM-SOLVING.

IN University of Cincinnati Ed.D.
1991, 273 pages.

SO DAI V52(07), SecA, pp2511.
DE Education, Technology.

The purpose of this study was to synthesize, in a quantitative manner employing meta-analysis techniques, the results of research

using computer graphics to determine whether this feature of computer programs improve mathematics achievement and problem-solving as measured by standardized and researcher-developed tests. This results of this study provide direction for developers and uses of computer software as well as educational policy makers as they incorporate the use of graphics software into mathematics curriculum.

The meta-analysis included 31 articles, 46 dissertations, three ERIC documents and a technical document published between 1983 and 1990 on the effectiveness of computer graphics on mathematics achievement and problem-solving. One hundred thirty-nine effect sizes were generated from these studies with 83 effect sizes produced in mathematics achievement studies and 56 effect sizes produced in problem-solving studies. The weighted average effect size for the mathematics achievement studies was 0.26. In a typical class, the performance of the students in the computer group was increased by 0.26 standard deviations or from the 50th to the 60th percentile. The weighted average effect size for the problem-solving studies was 0.34. In a typical class, the performance of the students in the computer group was increased by 0.34 standard deviations or from the 50th percentile to the 63rd percentile.

Two distinct types of graphic software, application software and LOGO, were employed in the studies using computer graphics to present mathematical concepts. The weighted average effect size for the mathematics achievement studies using application software studies was 0.44. In a typical class, the performance of the students in the computer group was increased by 0.44 standard deviations or from the 50th percentile to the 67th percentile. The weighted average effect size for the problem-solving studies using Logo was 0.41. In a typical class, the performance of the students in the computer group were increased by 0.41 standard deviations or from the 50th percentile to the 66th percentile.

Setting variables that contribute significantly to increased mathematics achievement were locally produced software and students working collaboratively instead of individually. Students of younger age groups and those in urban communities benefited most from graphic software used to support mathematics achievement. Students of low socioeconomic status and those of multi-ethnic status benefited significantly from graphic software used to support problem-solving performance.

AN UMI Order No. ADG91-36948
AU KIM, JONG-YEON LEE
TI THE EFFECTIVENESS OF CORRECTIVE FEEDBACK STRATEGIES AND THEIR INTERACTION WITH LEARNER INTEREST AND THE AMOUNT OF TREATMENT

IN The University of Iowa Ph.D.
1991, 165 pages.

SO DAI V52(07), SecA, pp2511.

DE Education, Technology, Education, Curriculum and Instruction, Artificial Intelligence.

The purpose of this study was to investigate the effectiveness of two corrective feedback strategies in computer-based instruction and their interaction with learner interest in subject matter and the amount of corrective feedback (the amount of treatment). In the first corrective feedback strategy, the computer provided knowledge of results (a message such as "Wrong") and the correct answer, when a response was incorrect. In the second corrective feedback strategy, the computer provided additional elaborate information about the reasoning for the correct answer as well as the knowledge of results and the correct answer itself, when a response was incorrect.

The subjects in this study were one hundred and five college students, who had little knowledge of Artificial Intelligence. Subjects first completed a survey which measured their initial interest in learning about Artificial Intelligence. Secondly, the subjects received instruction on Artificial Intelligence through a computer-based tutorial and then completed a second survey, which measured their post-instructional interest in the subject matter. Subjects were randomly assigned to one of two computer-based drills which provided practice on the material presented in the tutorial. The two drills differed only in the way feedback was provided in the case of incorrect responses. Immediately after completing the drill, subjects took a posttest.

Multiple regression analysis revealed that the complex corrective feedback given by a computer-based drill is more effective in terms of the student performance on the posttest than the simple corrective feedback. The superiority of complex corrective feedback was not diminished by the students' interest in the subject matter, the amount of corrective feedback the student received, or both factors simultaneously. In conclusion, when a response is incorrect, providing additional elaborate information about the reasoning for the correct answer as well as

the knowledge of results and the correct answer itself stimulates greater learning than just providing the knowledge of results and the correct answer.

AN UMI Order No. ADG91-36758
AU VICENTE, KIM J.

TI SUPPORTING KNOWLEDGE-BASED BEHAVIOR THROUGH ECOLOGICAL INTERFACE DESIGN

IN University of Illinois at Urbana-Champaign Ph.D. 1991, 251 pages.

SO DAI V52(07), SecB, pp3832.

DE Engineering, Industrial, Psychology, Experimental.

Many issues pertaining to the design of interfaces for complex human-machine systems remain to be investigated. A theoretical framework, called Ecological Interface Design (EID), was developed to address some of these topics. EID is based on Rasmussen's skills, rules, knowledge taxonomy and consists of three prescriptive design principles. The objective of these principles is to exploit the powerful capabilities of perception and action, while at the same time, providing the necessary support for more effortful and error-prone problem solving activities. This research evaluated how well an interface based on the principles of EID allows operators to cope with problem solving activities associated with unfamiliar and unanticipated events. According to EID, to properly support such knowledge-based behavior, an interface should display the physical and functional properties of the work domain in the form of a multilevel representation based on Rasmussen's abstraction hierarchy. A review of the literature in this area revealed that no experiment has ever compared a multilevel interface based on an abstraction hierarchy representation with another type of interface. An experiment was undertaken to address this important research need.

The experiment was conducted within the context of DURESS (DUal REservoir System Simulation), a thermal-hydraulic process control simulation. The performance of two interfaces was compared: a traditional interface based on a physical (P) representation, and an EID interface based on a multilevel physical/functional (P + F) representation. To evaluate how well these two interfaces support knowledge-based problem solving activities, a methodology based on psychological research on the relationship between expertise and memory recall was adopted. Thus, subjects were presented with a dynamic scenario of DURESS' behavior and were asked to diag-

nose the event and to recall the state of the system. There were three types of events: normal, fault, and random. Two groups of subjects were used: theoretical experts in thermal-hydraulics and novices. Collectively, the findings are consistent with the following conclusion: An interface based on an abstraction hierarchy can provide more support for knowledge-based behavior than an interface based on physical variables alone because it results in a better match to the theoretical expert's mental model.

AN UMI Order No. ADG92-01417
AU YE, NONG

TI DEVELOPMENT AND VALIDATION OF A COGNITIVE MODEL OF HUMAN KNOWLEDGE SYSTEM: TOWARD AN EFFECTIVE ADAPTATION TO DIFFERENCES IN COGNITIVE SKILLS.

IN Purdue University Ph.D. 1991, 153 pages.

SO DAI V52(07), SecB, pp3832.

DE Engineering, Industrial.

Knowledge processing has a key effect on human performance in cognitive tasks. Based on previous studies in cognitive science and artificial intelligence, an integrated cognitive model of human knowledge system has been developed and validated. This cognitive model covers three dimensions of human knowledge system, namely knowledge structure, knowledge content and control strategy. It is suggested that human knowledge is structured as a schema-based semantic network, and that human knowledge content is organized in a five-level abstraction hierarchy. In such schema-based semantic network which spreads over the five levels of abstraction hierarchy of knowledge content, three types of control strategies, namely simple search strategy, schema-driven processing and goal-directed processing, are used to search and access knowledge for human's cognitive tasks.

From the cognitive model, three hypotheses about skill differences due to human knowledge structure, knowledge content and control strategy are derived. These three hypotheses have been tested in three separate experiments. All three experiments utilized the same group of ten expert and ten novice programmers. In experiment one, subjects were required to provide pairwise relevance ratings of 23 concepts in C programming language and 21 concepts in the UNIX operating system so that their knowledge structure could be evaluated. In order to evaluate the knowledge content in experiment two, subjects were asked to complete a

multiple choice test for the five levels of software development knowledge. In experiment three, subjects were required to understand three C programs. Their program understanding process was analyzed in order to derive their control strategies. The three hypotheses were supported since significant differences were present in knowledge content and control strategies between experts and novices but not in their knowledge structure.

The developed cognitive model of human knowledge system has important implications in man-machine system design, knowledge system design, personal training and job design. The information gained on skill differences between experts and novices in human knowledge system can be applied to improve productivity and job satisfaction of cognitive tasks.

AN UMI Order No. ADG92-00271

AU SHENOUDA, WAGIH A.

TI ONLINE SEARCH STRATEGY MODIFICATION BY END USERS

IN Rutgers The State University of New Jersey (New Brunswick) Ph.D. 1991, 371 pages.

SO DAI V52(07), SecA, pp2304.

DE Information Science. Library Science.

The study investigated how end users interact with an information retrieval system (IR) in a natural environment. The study focused on identifying the processes by which end users modify their initial search strategies in the light of new information presented during the online process. This exploratory study was also conducted to examine the effectiveness of such modification in retrieving relevant documents and to identify characteristics associated with end-users' online search behavior.

Moreover, the study aimed to explore possible relationships between a number of variables associated with users' problematic situation and the search process and outcome.

Twenty users were recruited; each had an actual problem for which information was sought. None had any prior online searching experience. After receiving a basic training program, each user developed the query, identified its main concepts and their logical relationships, and selected appropriate database(s) from DIALOG. With the help of an intermediary who performed only the mechanical operations, each user conducted the online search without any constraints of time or cost.

The major findings indicate that all end users modified the search strategy during their interaction with the system. Categories of actions for modification, as well as categories of reasons for invoking such actions, were developed and identified in each search. The actions most frequently taken were associated with the deletion and addition of terms and facets. Reasons for invoking these changes were mainly related to relevance decisions.

Characteristics of end users' online search behaviors were identified. Overall, they reflect a learning process during which users became aware of how to communicate effectively with the system. Some of the system features were used more than others. Individual differences among users were demonstrated. Some users' problematic situation variables had positive relationships with the number of actions for modification as well as with precision.

AN UMI Order No. ADG91-28141

AU ALVEY, PATRICIA ANN

TI COMPUTER IMAGING AND THE CREATIVE PROCESS OF DESIGN: AN EXPLORATORY INVESTIGATION

IN The University of Texas at Austin Ph.D. 1991, 195 pages.

SO DAI V52(07), SecA, pp2308.

DE Mass Communications. Fine Arts. Education, Technology.

The computer is now one of the major devices used in conceptualizing, developing, and producing materials for both the print and electronic mass communications media. Word processors completely revolutionized the work of writers, editors, production staffs, and publishers. Computer imaging hardware and software are doing the same to the daily lives of graphic designers, and, quite possibly, studio artists. Research exists that attempts to understand the cognitive processes of the writer while working at the word processor. However, no empirically supported literature addresses the relationship between the artist and the electronic design station.

The goal of investigating the computer's impact on the creative thought process is to understand whether the use of the computer is influencing the design process in a way that requires changes in teaching, training, or working methods. The computer, with its ever-increasing capabilities, is changing forever the visual communications industry. And, more importantly, it may be changing the very process of creativity. If a major shift in the creative process is occurring, conceptual thinkers could be missing the ideation

and incubation phases so important to truly creative ideas.

This work begins with a review of three relevant fields of thought/research on the topics of creative process, and computers and human behavior: (1) computers in the publishing, fine art and design fields; (2) theories and models of creative thought; and (3) computers and human behavior. Research questions are then stated and linked, where possible, to existing research or academic thought. The chapter on research methodology presents research questions, the research design, the sample, and procedure. The results chapter reports statistics at the descriptive and inferential levels.

A final chapter discusses the findings of the research, examines its limitations, and draws conclusions as to the measure of the computer's impact, if any, on the creative thought process. All research instruments and references are contained in the appendices.

AN UMI Order No. ADG91-35659
AU NILSEN, ERIK LLOYD
TI PERCEPTUAL-MOTOR CONTROL IN HUMAN-COMPUTER INTERACTION
IN The University of Michigan Ph.D. 1991, 113 pages.
SO DAI V52(07), SecB, pp3931.
DE Psychology, Experimental. Computer Science. Psychology, Physiological.

Three experiments compared the speed and accuracy of item selection from two types of hierarchical pop-up menus (click-open & walking). These menus are perceptually equivalent, but require very different action sequences to make selections from them. Two ways in which the action sequences differ involve (1) the amount of spatial constraint in the movement path, and (2) the position of the mouse button during the movement. The present results show that selection from click-open menus is faster and less error-prone than selection from walking menus. This disagrees with the Key-stroke-Level Model of Card, Moran, and Newell (1983).

The difference in selection times for the two menu styles stems from the position of the mouse button during movement. In particular, moving with the mouse button depressed (walking menus) is slower than moving with the mouse button released (click-open menus). It appears that this difference is caused by the postural awkwardness of moving with the button depressed throughout the primary phase of move-

ment. The difference is not caused by (1) greater working-memory load, (2) greater friction between the mouse and the mouse pad, or (3) greater difficulty in coordinating the end of the movement phase with the terminal button release in walking menus.

With numerically-ordered menus, selection time is dominated by motor factors and is well modeled by Fitts' law for both click-open and walking menus. With randomly organized menus, selection time is dominated by a systematic, top-to-bottom search process. Visual search and mouse movement are parallel rather than serial processes.

Present results indicate the need for a process model of human-computer interaction that accommodates both serial and parallel processes. A start is made toward specifying such a model through the critical-path scheduling used by Schweikert (1978) and John (1988). Implications for menu selection and other computer-based tasks are also discussed.

AN UMI Order No. ADG91-37442
AU SUGIYANTO, YAN
TI EFFECTS OF AUTOMATION ON DECISION-MAKING PERFORMANCE
IN University of South Dakota (0203) Ph.D. 1991, 99 pages.
SO DAI V52(07), SecB, pp3932.
DE Psychology, Experimental. Increasing automation changes allocation of functions between humans and machines. The present study investigated three modes of automation in a simulated air traffic control system for two types of operation (normal and abnormal) and two workload conditions (heavy and very heavy). Ten subjects were assigned randomly to each of the three modes of automation. The subjects' task was to make a series of decisions when there were aircraft in conflict with each other in the air traffic configuration.

Results indicated that for mean reaction time and percent correct responses, mode of automation by type of operation interactions were significant. The mode of automation by workload condition interaction for percent correct responses was also significant.

The findings demonstrated that the subjects most effective decision-making performance was in the medium level of automation for both types of operation and both workload conditions.

AN UMI Order No. ADG92-01558
AU GIULIANO, CHRISTOPHER

PAUL

TI EFFECTS OF INTERACTIVE AND LINEAR VIDEO ON PATIENT UNDERSTANDING OF RISKS IN MEDICAL PROCEDURES

IN Western Michigan University Ph.D. 1991, 44 pages.
SO DAI V52(07), SecB, pp3890.
DE Psychology, General. Health Sciences, Medicine and Surgery.

Three methods of providing information relevant to informed consent where a vaginal birth after cesarean section was being considered were evaluated: (1) the traditional and common method (physician presentation), (2) Linear Video Tape (LVT), and (3) Interactive Video Disc (IVD). The traditional and common method of presenting information led to only limited acquisition of knowledge resulting in patients making less than fully-informed decisions. Both the linear video tape and the interactive video disc led to significantly greater understanding of the risks and benefits of the procedure than did the physician presentation. The interactive disc and the linear video tape were equally effective in providing information relevant to the informed consent process, but the interactive video disc was more often viewed as being helpful in the process of making an informed decision. Additional advantages of the interactive video disc as an aid in providing a legally valid informed consent were discussed.

This thesis was submitted with Diss. pub.#9201559 as partial fulfillment of a Ph.D.

AN UMI Order No. ADG91-35695
AU SMIT, PETER HANS
TI DESIGNING HYPERTEXT RETRIEVAL SYSTEMS FOR POLICY ADVISERS, REVIEW AND EVALUATION
IN The University of Michigan Ph.D. 1991, 357 pages.
SO DAI V52(07), SecA, pp2728.
DE Urban and Regional Planning. Political Science, Public Administration. Business Administration, Management. Information Science.

This study investigates the responses of policy advisers to selected features of a proposed hypertext system. Hypertext is a novel computerized information system that makes text available in the form of short segments which refer to each other and which can be retrieved in any order. The study also provides literature reviews of selected,

optional hypertext features, of research on reading texts of different lengths, and of prototyping techniques for the early stages of system development.

The output of different versions of a hypertext system was shown to policy advisers at a large government office in Washington D.C. Results indicate: (1) The choice between displays of up to 12 or 24 lines in length does not affect policy advisers' evaluations of the information system prototype. However, the evaluations do show some interactions: small displays are negatively related to appreciation for a searching tool, positively related to appreciation of the system with an alphabetical index, and large displays are positively related to expected ease of use of the system with the index. (2) Text and index are evaluated reasonably positively in the disaggregated form that hypertext requires. However, evaluation of a system version with a searching tool, also presented in disaggregated form, is not as good as evaluation of a system version without that tool under particular circumstances (when the displays are small, and when the version without the tool is shown first).

The study offers suggestions to improve the design of the searching tool and to improve other features of the demonstrated system, based on comments made during fifty evaluations.

The prototyping technique used here does not require programming or expensive recording equipment, thus allowing almost any office worker to pretest proposed software or software improvements before calling on a computer specialist for actual development and implementation.

AN UMI Order No. ADG92-05887
AU BYRER, JOYCE KAY
TI THE RELATIVE EFFECTIVENESS OF A DIRECT MANIPULATION INTERFACE VERSUS COMMAND-BASED INTERFACE IN A DATABASE QUERY TASK ENVIRONMENT

IN Indiana University Ph.D. 1991, 281 pages.
SO DAI V52(09), SecA, pp3334.
DE Business Administration, General. Psychology, General. Computer Science.

Over the past decade, five different styles of interaction between users and computers have evolved: (1) menu selection, (2) form fill-in, (3) command language, (4) natural language, and (5) direct manipulation. All five have proven successful for particular

applications. However, one of the five styles, direct manipulation, stands out as the most "visual".

A major question posed by both practitioners and software developers is "Do direct manipulation interfaces provide a more effective interface for computer users?" Researchers have examined particular aspects of the diversity of interaction styles and techniques and have determined that direct manipulation interfaces have not been shown to be universally more effective. Human-computer interface studies have identified a complex relationship between the computer task, users who carry out the task, the environment in which they work, and the information system that they are using.

This study investigated one particular combination of these factors that has received little attention to date. More specifically, this study compared novice users performing database query tasks with two direct manipulation interfaces and a command-based interface. Fifty-one subjects were randomly assigned to one of three database interfaces. During each experimental session, each subject was given "hands-on" training with a computer in the construction of database queries. As the subjects proceeded through the training, they were given three sets of query tasks, each successively more difficult. Comparisons focused on the effects of the different database query interfaces on user performance (as measured by the correctness in tasks and performance time) across the different database tasks (one-table, two-table, and three-table), as well as on user attitudes (as measured by confidence in their answers and perceived ease-of-use).

The results indicated that direct manipulation interfaces, as a whole, do not lead to significantly better user performance in formulating table queries. Users of one of the direct manipulation interfaces performed very similarly to the users of the command-based interface. On the other hand, users of the second direct manipulation interface performed significantly better than users of the other two interfaces. This study suggests that the design features that minimize user errors may be a more important criteria in determining user performance than whether the interface is direct manipulation or command-based.

AN UMI Order No. ADG92-01555
AU WU, BRUCE JIINPO
TI THE EFFECTS OF DATA MODELS AND CONCEPTUAL MODELS OF THE STRUC-

TURED QUERY LANGUAGE ON THE TASK OF QUERY WRITING BY END USERS

IN University of North Texas Ph.D. 1991, 192 pages.

SO DAI V52(08), SecA, pp2989.

DE Business Administration, Management. Computer Science. Education, Business.

This research is an empirical investigation of human factors on the use of database systems. The problem motivating the study is the difficulty encountered by end-users in retrieving data from a database. The independent variables are the users' mental model of the system, and the data model. The dependent variable is the user's query writing performance, as measured by the number of syntax and semantic errors, as well as the amount of time required to complete a query task.

A laboratory experiment approach was employed. The experiment was structured as a three-by-three factorial design. One factor was the type of the data model. Data models were used to present database contents to end-users. The second factor was the type of the conceptual model of the structured query language. The conceptual models with different descriptions of the structured query language were used to build users' mental model of the query language system. Students were used as surrogates of business computer end-users. Test cases were developed and administered to students. Student query writing performance was coded and analyzed.

The results of statistical analysis on the collected data exhibited several critical findings. The number of semantic errors committed when writing database queries was affected by the utilization of conceptual models. The diagram model as a conceptual model of the structured query language was superior to other conceptual models. The semantic errors committed in near-transfer high-complexity tasks were affected by data models. The syntax errors committed either in all query tasks or in each task category were neither affected by the use of different data models, nor influenced by the use of different conceptual models. The time required to complete query tasks was not affected by either data models or conceptual models. No interaction effects were found between the two manipulated variables.

AN UMI Order No. ADG92-01921
AU BUCKNER, RICHARD LEE
TI MULTIPLE WINDOWS AND TASK COMPLEXITY EFFECTS UPON HUMAN-COMPUTER

INTERFACE VIEWABILITY AND PRODUCTIVITY

IN Claremont Graduate School Ph.D.
1992, 311 pages.
SO DAI V52(08), SecB, pp4304.
DE Computer Science. Business
Administration, Management.
Information Science.

This research postulates that windows substitute for and aid associative memory in software development and support online tools. Prior windows research asserts that windows aid or relieve short term working memory. The software engineer relies upon long term associative memory developed in work experiences in considering all software structures related to problems when fixing them. The software quality engineer, not having done the development, has no equivalent long term associative memory and finds it hard to check changes. To correctly make approvals, software quality assurance must understand the interrelationships between modules, and must rely upon documentation as a substitute for the developers' associative memories. Windows can simultaneously display all document files related to a change, aiding associative memory and freeing other cognitive resources for the work at hand.

A cognitive systems engineering model of complexity is used as a human ergonomics factor in an abstract expression of the utility of a software quality assurance human-computer interface related to complexity and three information science attributes of the visual display tube. Viewability--an originally identified information technology construct--is isolated from accessibility, which is well documented. Optimum number of windows is also considered an information technology construct dependent upon complexity. This research asserts that viewability and accessibility are fundamental constructs of the visual human-computer interface, and that optimal number of windows is a component of accessibility. The model includes concepts of Rooms and panes.

A complete, 3 x 3 factorial, partially counterbalanced, block design, with three replications of viewability and most productivity measures, tests some hypotheses resulting from propositions that multiple windows increase interface utility and software quality assurance productivity. Maximum number of windows allowed operationalizes viewability, and task complexity implements complexity. The subject pool size was 24, and up to 648 observations yielded p values much less than the significance criterion of .05 with no interactions, indicating viewability depends upon number of windows

allowed, is independent of complexity and does not increase productivity. Optimal number of windows was shown to depend only upon complexity, as were productivity measures of efficiency, effectiveness and agent satisfaction.

AN UMI Order No. ADG92-06746
AU CHA, SANG KYUN
TI KALEIDOSCOPE: A MODEL-
BASED GRAMMAR-DRIVEN
MENU INTERFACE FOR
DATABASES

IN Stanford University Ph.D. 1991,
141 pages.

SO DAI V52(09), SecB, pp4827.
DE Computer Science. Engineering,
Electronics and Electrical.

Most database interfaces provide poor guidance on ad hoc query formulation, burdening end users to learn, and to recall precisely the query language and the database. This dissertation presents the interface and design approach of Kaleidoscope, an interface that reduces the user's cognitive burden in query formulation.

Kaleidoscope guides the user's query formulation in an English-like query language (EnQL) via a context-sensitive menu system. Based on a grammar specifying the syntax and semantics of EnQL, this system generates legitimate EnQL query constituents step by step as menu choices. This grammar-driven menu guidance enables users to construct a meaningful query by recognizing choices that match their mental query. The interface provides additional intraquery conceptual guidance to ensure the integrity of a partial query.

The central thesis of this work is that a data model plays a crucial role in the Kaleidoscope's style of interfaces, as a query language conveys the underlying conceptualization of data to the user. The design of grammar, lexicon, and query translator follows a formally defined data model. The absence of an explicit model leads to the ad hoc design of these components, harming the system's transportability. In the model-based approach, the grammar design focuses on unambiguously realizing references to model concepts. As a result, all user queries are meaningful with respect to the underlying data model. The model also provides the basis of defining two other domain-independent modules: a query translator and a set of procedures for automatic generation of lexicon from the schema.

The major technical contribution of this thesis is a data model formalizing the con-

ceptual structure of restricted English queries. Existing data models are inadequate for near-natural language interaction with database systems because of a significant conceptual gap between common English concepts and database representation of such concepts. EnQL, based on our model, enables the user to express significantly more concise queries than SQL, often by an order of magnitude. To provide a complete normative design framework, this thesis also presents a cost model of user query production when using grammar-driven menu interfaces. This model is useful for evaluating alternative interface designs.

AN UMI Order No. ADG92-06070
AU CHRISTEL, MICHAEL
GEORGE

TI A COMPARATIVE STUDY OF
DIGITAL VIDEO INTERAC-
TIVE INTERFACES IN THE
DELIVERY OF A CODE
INSPECTION COURSE

IN Georgia Institute of Technology
Ph.D. 1991, 293 pages.

SO DAI V52(09), SecB, pp4827.

DE Computer Science. Information
Science. Education, Technology.

Past research into interactive video educational software has focused primarily on comparing the instructional effectiveness of an interactive video course with more traditional media, such as classroom lecture. Typical effectiveness measures include recall performance and attitude shifts. While such research generally finds in favor of the interactive video course, few formal examinations of the course exist to explain these results, including studies into the contributions of the interface design. An interactive digital video code inspection course was used to investigate whether the capabilities of digital video interfaces provide any advantages in an educational computer course.

Two by two factorial experiments were conducted to determine the effects of a computer course which included motion video versus one which contained no such video, and the effects of navigating through a series of related still images (surrogate travel) versus clicking a mouse on predefined areas of a single still image. The effects under study were recall performance, and shifts in meaning, measured with semantic scales, toward code inspection-related terms and educational media terms.

The code inspection course, developed at the Software Engineering Institute on a Digital Video Interactive platform, was used by seventy-two college seniors and master's stu-

dents. Each student used one of these four treatments of the course in isolation for up to three hours.

The findings suggest that the presence of motion video in interfaces can lead to better recall performance than if no motion video exists in the interface. Material containing some motion video will be recalled better than if the same material is presented as audio with still images.

There were also significant differences in the shifts in meaning, calculated by subtracting a pretest score from a post test score, produced by the motion video and navigation independent variables. After the course, the surrogate travel navigation subjects rated code inspection-related terms as more powerful and "classroom instruction" as less powerful than the single still navigation subjects. Subjects receiving motion video shifted their views of code inspection concepts toward more active than did the subjects receiving no motion video.

AN UMI Order No. ADG92-03280
AU MALONEY, JOHN HAROLD
TI USING CONSTRAINTS FOR
USER INTERFACE CON-
STRUCTION

IN University of Washington Ph.D.
1991, 193 pages.

SO DAI V52(08), SecB, pp4316.

DE Computer Science.

Interactive, direct-manipulation, graphical user interfaces are easy to use but difficult to construct. This dissertation shows that automatic constraint satisfaction is useful in many facets of user interface construction and demonstrates that it is feasible.

A constraint represents a desired relationship between variables. While some constraints are required to be satisfied, others may be merely preferred to varying degrees. Such preferential constraints allow the programmer to control the behavior of the constraint solver declaratively. In user interface construction, constraints can represent relationships at three levels: between application data structures and user interface components, between the components of a user interface, and between the parts of a compound component. A system that automatically maintains these relationships frees the programmer from many tedious and error prone tasks.

This dissertation focuses on a constraint satisfaction technique known as local propagation. It shows how to frame local propagation as a graph problem, and proves that, in general, this problem is NP-com-

plete. It then identifies a restricted form of the problem that can be solved efficiently by the DeltaBlue algorithm, an incremental local propagation solver that handles preferential constraints.

The major contributions of this dissertation are to prove that the DeltaBlue algorithm is correct, to demonstrate that it is fast enough to provide low latency, high bandwidth interactive feedback in systems with as many as 20,000 constraints, and to show that it is powerful enough to solve many of the constraint problems that arise in user interface construction. It also addresses a number of related issues, such as how to integrate constraints with imperative programs cleanly, how to model user inputs as constraints, how to compile constraints, and how to maintain constraints on collections incrementally. Finally, it describes ThingLab II, a programming environment for constructing constraint-based user interfaces, and its use to build a number of user interfaces.

AN UMI Order No. ADG92-06436

AU ROBERT, JOSEPHINE J.
SHANTHI

TI MEDRIS: DESIGN AND SOFTWARE ENGINEERING OF A
HYPERMEDIA MEDICAL
RECORD INPUT SYSTEM

IN Illinois Institute of Technology
Ph.D. 1991, 197 pages.

SO DAI V52(09), SecB, pp4839.

DE Computer Science.

MEDRIS, the MEDical Record Input System, uses hypermedia technology to collect and report patient data. MEDRIS functions as a stand alone system producing its own reports or as the front end for the expert system MEDAS, the Medical Emergency Decision Assistance System. MEDRIS produces a patient file for MEDAS, which MEDAS uses to produce a differential diagnosis, severity estimates, test selection, progress notes, and treatment protocols. MEDRIS runs on Macintosh computers and uses windows, pulldown menus, customized cursors, 2D-graphics, color, and mouse input, to offer an easy-to-use environment for its users (mostly, physicians, residents, and medical students). The system was developed using SuperCard version 1.5.

The design of this system addresses the following issues: (1) proper identification and linking of graphic objects and pop-up menus in the system to provide a natural working environment for physicians, (2) use of a systematic approach for collecting data so that the system can be used as an educational tool as well as a clinical system to collect data accurately and completely, and (3)

use of efficient navigational facilities for quick transition within the system.

MEDRIS was developed using novel software engineering techniques that greatly simplified and speeded up the development process. Libraries of objects and tools were constructed to simplify the development process and make the system consistent. A pilot study was run to evaluate the user interface offered by MEDRIS, and to find out the time taken by users for entering patient data. 27 subjects including 9 physicians, 12 residents, and 6 fourth year medical students participated in the study. The study results show that the participants involved in the study rated the user interface of MEDRIS highly. The overall rating of the system was 8.68 on a scale of 1 to 10. The mean input time for entering the data for one patient was found to be 14.09 minutes. The general reaction of the study participants to MEDRIS was that it is very useful and easy-to-learn. The study also revealed areas that need to be improved such as the system response time and the report format before it is implemented in a clinic or a hospital.

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AU ROUFF, CHRISTOPHER
ANDREW

TI SPECIFICATION AND RAPID
PROTOTYPING OF USER
INTERFACES

IN University of Southern California
Ph.D. 1991.

SO DAI V52(08), SecB, pp4319.
DE Computer Science.

This thesis present a model for specifying and a system for rapidly prototyping user interfaces. The model represents the components, flow of control, constraints, and semantic feedback of an interface while the system allows an interface to be prototyped with little or no programming. As a user interface is prototyped, a model of the interface is built that represents its structure and functionality. This model can then be compiled into a stand alone program with calls to the X windows and Motif libraries. The generated program is compiled and linked to application functions to produce an executable program.

The model, IRGs (Interface Representation Graphs) differs from previous user interfaces models in that it is designed for asynchronous multiwindow user interfaces. Other models force an explicit flow of control between states of the interface and do not take into account the implicit flow of con-

trol that occurs between windows and objects in asynchronous user interfaces. IRGs provides for this implicit flow of control as well as three other types of flow of control, a representation for the hierarchical structure of components, constraints between components, and interaction with an underlying application.

The system, RPP (Reduced Programming Prototyper), differs from other user interface builder or UIMS systems in that it is based on a formal graph model, IRGs, while the others are based on programming languages. RPP also differs from other systems in that it allows complex sequencing, constraints, and the application interface to be defined interactively. Other systems restrict interactive definitions to layout only and specify the dialogue in a programming language, thus requiring a programmer to learn yet another language. (Copies available exclusively from Micrographics Department, Doheny Library, USC, Los Angeles, CA 90089-0182.).

AN UMI Order No. ADG92-00864
 AU SUKAVIRIYA, PIYAWADEE
 TI AUTOMATIC GENERATION OF CONTEXT-SENSITIVE ANIMATED HELP
 IN The George Washington University D.Sc. 1991, 254 pages.
 SO DAI V52(08), SecB, pp4322.
 DE Computer Science.
 Context-sensitive animated help uses simple 2-dimensional animation to demonstrate how to perform a computer application task within the context in which help is requested. To automatically generate such help, descriptive information about an application, its interface design, and runtime context must be available to a help generation system. This dissertation addresses how to represent domain-independent help knowledge, which is suitable for automatic generation of procedural animated help. The dissertation also presents the design of a help architecture which allows help and user interface components to share runtime contextual information. Within the environment this architecture supports, help can be tailored specifically to the user's current context.

In this dissertation research, a knowledge representation model is developed that sufficiently details an application interface for both animated help generation and user interface control purposes. The knowledge model captures the semantics of application actions, their relationships to user interface components and functionality, and interface details required to support accurate demon-

strations that are adaptable to current contexts. A model for a runtime support architecture with an integrated help component is also developed, in which help and user interface components share a common knowledge base to generate context-sensitive animated help automatically at runtime and to assist the management of use interfaces. The animated help component has access to contextual information, and employs artificial intelligence planning techniques to tailor animation scripts specifically to current contexts. Based on these models, a system called Cartoonist is implemented to demonstrate the usefulness of both the knowledge representation and the software architecture models.

AN UMI Order No. ADG92-05848
 AU WESTON, JOAN ELLARD
 TI HOW THE WORD PROCESSOR INFLUENCES INTERACTIONS BETWEEN COLLABORATING GRADE FOUR STUDENTS
 IN University of Oregon Ph.D. 1991, 191 pages.
 SO DAI V52(09), SecA, pp3173.
 DE Education, Curriculum and Instruction. Education, Teacher Training. Education, Technology.
 This is a descriptive study of paired fourth grade students as they used a word processor. The purpose of the research was to determine how students collaborated, what they learned from each other, how they balanced their roles as writer or helper, how they incorporated their ideas into their writing, and how they managed the give and take of ideas. This research was facilitated by the computer location, which gave the students privacy to speak naturally as they progressed through a variety of teacher-made weekly writing assignments over a period of eight weeks. The behaviors of the students were videotaped and studied for roles and patterns in their collaborative efforts.

The 12 students said they wrote better with a partner and preferred to work with someone while at the computer. In spite of minimal instructions from their teacher consisting mainly of: "Work together and take turns," the students exhibited the following positive and collaborative behaviors: took turns, balanced roles, asked questions, gave assistance, listened actively, brainstormed for ideas, scaffolded their ideas to build sentences, encouraged their partners to participate, taught each other needed skills, took risks, and socialized, but stayed on task.

A prerequisite for the study was the skill of keyboarding. Although the students had used a keyboarding program for six weeks prior to the study, they could not keyboard efficiently. This lack of skill became an important part of collaboration within the pairs. Overall, the students worked consistently with their regular partners, and were able to adjust when circumstances required a replacement. The students coped well considering the variety of their assignments. Simple revisions were done as they constructed their sentences.

Implications question the need for extensive training to begin cooperative grouping. According to this study children will cooperate if given the freedom to chat as they work, in order to build knowledge and relationships.

Recommendations are for more extended studies of this type, following children as they learn to keyboard effectively and as they begin writing in pairs, over an extended period of time.

AN UMI Order No. ADG92-06013
 AU MAIDENBERG, EMANUEL
 TI EXPERTISE IN ONLINE INFORMATION RETRIEVAL
 IN University of California, Los Angeles Ph.D. 1991, 207 pages.
 SO DAI V52(09), SecA, pp3225.
 DE Education, Psychology, Education, Technology. Library Science.
 New information technologies offer the promise of major improvements in human problem-solving skills. Whether or not this promise will be achieved depends on the development of a better theoretical understanding of information-seeking behavior and using this knowledge to improve online systems. This research is driven by these fundamental considerations.

A particular interest was in the process of subject-based searches where users search for unknown documents on certain topics of interest in an online database.

The assumption underlying this research was that responsive systems should incorporate functional behaviors of an expert in online information retrieval. The major objectives of the research were: (1) to analyze those behaviors correlated with success in online searching (User-System study), and (2) to identify the functions which must be performed by the human intermediary in order to successfully interact with the user (User-Librarian study).

In the User-System study, 15 experienced

searchers and 15 novices were compared on search outcome and search process variables. In the User-Librarian study, 15 interactions between librarians and users who required assistance in searching for information were observed and analyzed.

The primary method was to make video recordings of user/system interactions and audio recordings of user/librarian interactions in online searches and to subject the transcripts to detailed functional analysis.

In the User-System study, the main results were that, as expected, experienced searchers performed significantly better than novice searchers. The search process measures revealed considerable differences between the two groups: novices had more difficulties in developing appropriate search terms and operating the system, employed less effective term-refinement strategies, and did not have enough previous knowledge to rely upon while searching. Searchers' difficulties as well as knowledge components needed for successful search were identified.

In the User-Librarian study, assistance strategies and knowledge resources used by librarians in the process of search consultation were studied in depth. Functional stages of the online search process were defined and a taxonomy of heuristics employed by librarians at each of the stages was developed.

Implications of the findings for the development of a more responsive information retrieval system were outlined.

AN UMI Order No. ADG92-04455
 AU MESHOT, CAROLE JEAN
 TI INTERACTIVE HYPERMEDIA: A COMPARATIVE STUDY OF THE EFFECTS OF REAL-TIME MOTION VIDEO-DISC VERSUS STILL FRAME AND OF COGNITIVE STYLE ON CETACEA ANIMALS KNOWLEDGE TEST FOR SECOND-GRADE STUDENTS

IN The University of North Carolina at Greensboro Ed.D. 1991, 138 pages.

SO DAI V52(09), SecA, pp3251.
 DE Education, Technology. Education, Elementary. Education, Sciences.

The purpose of this study was to determine the effects of real-time motion vs still frame presentation mode and cognitive style (field dependent versus field independent) on a interactive hypermedia knowledge task.

The field dependent and field independent cognitive style dimensions of 121 second grade students were determined by the administration of the Children's Embedded Figure Test. Forty field dependent individuals and 40 field independent individuals were selected, randomly assigned to treatment groups, and administered the Cetacea Animals Knowledge Test pre-test. Two groups each of 20 field dependent individuals and 20 field independent individuals received the hypermedia still frame presentation; two groups each of 20 field dependent individuals and 20 field independent individuals received the hypermedia real-time motion presentation. All groups were administered the Cetacea Animals Knowledge Test post-test.

The results of a 2 x 2 analysis of covariance indicated a significant effect of cognitive style on the post-test scores; field independent students scored higher than field dependent students. There were no differences between hypermedia still frame and real-time motion treatment sub-groups, and no interaction effects between cognitive style field independent and field dependent dimension and hypermedia still frame and real-time motion presentation treatment.

AN This item is not available from University Microfilms International - ADG05-70856
 AU OLIVER, LAURA ELIZABETH
 TI THE EFFECT OF VARYING LEVELS OF FEEDBACK AND ERROR MESSAGES IN INSTRUCTION ON THE PERFORMANCE OF A PROCEDURE

IN University of Southern California Ph.D. 1991.

SO DAI V52(08), SecA, pp2897.
 DE Education, Technology.
 This study investigated the effects of varying levels of feedback, with and without common error messages, on the performance of a procedure. The sample of 74 students was drawn from a Southern California High School. Subjects were taught a procedure via a microcomputer delivery system and were then required to perform the procedure to a predetermined level of mastery. The feedback conditions were varied within the practice segments of the instructional computer program.

Research hypotheses were examined by Multivariate Analysis of Variance and Analysis of Variance. There were no significant differences between groups on performance of the procedure, errors in practice, or errors

on the mastery test. Additional multivariate analyses using data which estimated missing data were also conducted. When the maximum values of each cell were substituted for missing data in a cell, there was a significant overall effect of common error messages on the mastery of the procedure. However, follow up univariate tests did not reveal any significant differences or interactions between groups. Data collected for a pilot study on state worry revealed that there was a significant interaction between feedback level and common error information in reported state worry levels. Reported post instruction worry was significantly different between the subjects that received the Knowledge of Results feedback without common error information and subjects who received Elaborative Feedback without common error information. Additionally, the reported worry levels of subjects who received the Elaborative Feedback without common error information were significantly higher than subjects who received Elaborative Feedback and common error information.

This study failed to support the hypothesis that the incorporation of common errors within feedback is an effective instructional strategy for teaching a procedure. Additionally, the study did not validate the inclusion of feedback, other than Knowledge of Results, in a procedure lesson. Research topics that can be studied in the future include the efficacy of performance aids in the learning of a procedure and the reduction of state worry levels in instruction as it relates to feedback. (Copies available exclusively from Micrographics Department, Doheny Library, USC, Los Angeles, CA 90089-0182.)

AN UMI Order No. ADG92-06027
 AU ROBINSON, SANDRA REBECCA
 TI LEARNING TO USE AN UNFAMILIAR WORD PROCESSING PROGRAM AS A FUNCTION OF PRIOR TASK EXPOSURE AND PROFICIENCY

IN University of California, Los Angeles Ph.D. 1991, 288 pages.

SO DAI V52(09), SecA, pp3251.
 DE Education, Technology. Education, Tests and Measurements. Education, Psychology.

Proficiency in using a computer to produce written documents has become an essential skill for individuals to possess in order to perform and to compete in many academic and professional settings. In this study, the skills and knowledge composing basic word

processing proficiency were identified using an instructional task analysis approach. From this analysis, a task-oriented definition was proposed and task-oriented performance measures and instructional materials were designed.

The dominant focus of this study was to examine the influence of prior task exposure and prior task proficiency on learning to use an unfamiliar word processing program. Task exposure (defined as the length of time spent executing tasks) was carefully distinguished from task proficiency (defined as the degree of competency demonstrated performing tasks).

Fifty-five graduate students were assigned to one of two groups on the basis of their level of prior word processing exposure. Information about subjects' computer, word processing, and writing backgrounds was gathered using a detailed questionnaire. The study's procedure included a performance-based pretest of basic word processing proficiency, an instructional intervention, a posttest, and an interview. The instructional intervention consisted of a tutorial on using Microsoft Word and a performance-based proficiency test.

The results were supportive of distinguishing task exposure from task proficiency in the domain of word processing. The findings contradicted the common practice of inferring a person's level of word processing competency from his or her degree of exposure to a word processing program(s). Very large positive training effects were observed after subjects completed the tutorial. Sharp increases in scores of task proficiency and ratings of ease performing tasks from the pretest to the tutorial test and posttest were indicative of the effectiveness of the training. At a grand level of analysis, these powerful training effects overshadowed any observable positive or negative transfer effects. However, using an item analysis approach, task-specific instances of positive and negative transfer were found. Implications of these findings for improving the instruction and assessment of word processing competency were discussed.

AN UMI Order No. ADG92-04633
 AU CASALI, SHERRY PERDUE
 TI AN EMPIRICALLY DEVELOPED SYSTEM FOR THE SELECTION OF COMPUTER INPUT DEVICES FOR USERS WITH PHYSICAL DISABILITIES

IN Virginia Polytechnic Institute and State University Ph.D. 1991 211

pages.

SO DAI V52(09), SecB, pp4915.
 DE Engineering, Industrial. Health Sciences, Occupational Health and Therapy. Psychology, Experimental.

The selection of a computer access method for persons with disabilities often results in a poor user-device match. This research has developed a systematic method for selecting a computer input device based on objective measures of hand skill.

Each input device being considered was first evaluated to determine the basic elements of motor performance which contribute to successful operation. Persons with various degrees of functional limitations of the upper extremities served as subjects. Each underwent a motor assessment test performed a series of computer-based tasks with each input device. The task is a modified target acquisition task with the independent variables of target size, target distance, mode (button up vs. button down) and trial block.

The participants' scores on both the assessment test and with each device were analyzed in order to form relationships between the two sets of shows. Results show that: (1) By comparing an individual's assessment test scores with the set of motor actions determined to be necessary to operate a device, one can immediately identify actions which are needed but unavailable. If no discrepancies exist, one can conclude that the client can operate that device. (2) Where discrepancies do exist, the assessment test targets the specific actions creating the difficulty. Then, one can recommend modification to the device which may allow better performance. (3) The effects of parameters such as target size, target distance, and practice were determined for persons with different levels of hand skill. Unexpectedly, several persons with disabilities performed equally well as persons without disabilities on some devices. Persons with limited hand skill required only slightly longer to become proficient users. The rank ordering of the devices with respect to input rates was the same for persons with and without disabilities. Persons with disabilities were more affected by the parameter of target size on all devices, particularly for button down moves.

This research not only developed guidelines concerning the five devices selected for use in this study, but also serves to demonstrate the feasibility and utility of an accommodative aid selection system based on functional assessment of a client's residual abilities.

This research also provides important information to hardware and software manufacturers regarding accessibility issues.

AN UMI Order No. ADG92-06088
 AU JONES, PATRICIA MARIE
 TI HUMAN-COMPUTER COOPERATIVE PROBLEM-SOLVING IN SUPERVISORY CONTROL
 IN Georgia Institute of Technology Ph.D. 1991, 371 pages.
 SO DAI V52(09), SecB, pp4954.
 DE Engineering, System Science. Computer Science. Psychology, Industrial. Artificial Intelligence.

In the supervisory control of a highly automated system, the human operator must manage information and activities in a complex, dynamic environment. This thesis explores the concept of a computer-based, "intelligent" operator's associate system as a means of providing context-sensitive, real-time aiding support to the human supervisory controller. First, a theory of human-computer cooperative problem solving is proposed that prescribes the requirements for an effective operator's associate. Based on the theory and the results of a case study, the design of an operator's associate for satellite ground control is described. The resulting system, the Georgia Tech Mission Operations Cooperative Assistant (GT-MOCA), was implemented in the context of an interactive, real-time simulation of the Mission Operations Room environment at NASA Goddard Space Flight Center. GT-MOCA provides task management, information management, and system visualization support for the human operator. This thesis provides a detailed description of GT-MOCA's operator modeling methodology, knowledge structures, and user interface. The results of an experimental evaluation of GT-MOCA by Flight Operations Team analysts at NASA Goddard are given, and show that GT-MOCA successfully addressed many of the issues in providing real-time support for human operators in the Mission Operations Room.

AN UMI Order No. ADG92-05891
 AU CROSBY, ELLEN
 TI USER INTERACTION WITH AN ONLINE CATALOG: MEASURES OF SUCCESS
 IN Indiana University Ph.D. 1991, 176 pages.
 SO DAI V52(09), SecA, pp3116.
 DE Library Science. Information Science. Education, Technology.

The successful use of a library catalog has traditionally meant simply finding a citation. Finding the citation, however, may

involve several contributing factors. This study developed a model to investigate the relationships among several variable using path analysis techniques. The model included catalog users' library experience and their computer experience as exogenous variables. Endogenous variables were the duration of the searches, search accuracy, search efficiency (number of commands), and users' perception of the search process.

Sixty-nine undergraduate students searched the Indiana University Library NOTIS online catalog in a controlled setting for answers to six questions supplied by the researcher. A fifteen-minute training task preceded the experimental session. For this group, library experience was correlated with computer experience ($r = .37$, $p < .01$). Results of the path analysis indicated that greater computer experience predicts shorter elapsed time. Search efficiency is predicted by elapsed time ($\beta = .86$, $p < .01$), but more computer experience leads to less efficiency ($\beta = .22$, $p < .01$). Accuracy of results was not related to search efficiency. Efficiency was not related to perception of searching.

Factor analysis was performed on scores on the perception instrument and four factors emerged. Two factors showed significant relationships to other variables. Participants who were accurate perceived the online catalog as a useful way of finding information ($\beta = .25$, $p < .05$). Searches of short duration predicted perception of usefulness ($\beta = -.22$, $p < .05$) and perception of self-sufficiency ($\beta = -.49$, $p < .05$). Previous library experience did not contribute significantly to the model. The factors related to liking of the online catalog and liking of the search process did not contribute to the model.

It is concluded that instruction in using online catalogs should concentrate more on computer skills than on skills involved in interpreting the catalog record. Relatively naive users are able to be successful in using an online catalog. Future research should provide further definition of elements involved in catalog users' perceptions of the search process.

AN UMI Order No. ADG92-01755
AU SLOANE, SARAH JANE
TI INTERACTIVE FICTION, VIRTUAL REALITIES, AND THE READING-WRITING RELATIONSHIP
IN The Ohio State University Ph.D.
1991, 223 pages.
SO DAI V52(08), SecA, pp2937.

DE Literature, English. Artificial Intelligence.

Interactive fiction, or stories read on the computer in which the reader takes on the role of a primary character who directs sequences of scenes, conversations with other characters, and narrative progression by typing short phrases or commands, provides a specific example of the new rhetorical dimensions evoked by computer-supported stories. This dissertation explores the experience of reading and writing interactive fiction and proposes a rhetorical theory that both encompasses computer-supported fictions and suggests directions for their development. The method of study to extend our understanding of the processes of reading, writing, and criticizing interactive fiction is an integrative study of works in narrative theory, artificial intelligence, and rhetoric as well as a contrastive reading of selected paper and computer fictions.

First, a newly problematic ethical dimension of reading interactive fiction is identified and explored by comparing the experience of reading an interactive fiction, Infocom's *Deadline*, with three paper fictions, Wilkie Collins' *The Moonstone*, Robert Coover's *"The Babysitter,"* and Italo Calvino's *If on a Winter's Night a Traveler*. Nonlinearity, multiple viewpoint, and second person address compound the effects of an interactive fiction reader's new capacity to control her or his narrative experience, resulting in a new ethical dimension to the experience of reading. Second, the reader's new responsibility for sequence and quality of event, and the accompanying ethical discomfort, is linked to the way interactive fictions are composed. Writing interactive fiction is explored in two mini-case studies of *The Oz Project* and *Interactive Fantasies*, and the realist epistemology underlying interactive fictions is critiqued. Finally, the transformations in the reading-writing relationship invoked by interactive fiction and other computer-supported texts lead to a reconception of the traditional rhetorical triangle. Materials, processes, and locations are proposed as descriptive terms intended to better describe the shifted temporal and spatial dimensions of the relationships among reader, writer, and text. The author concludes by proposing three research studies to extend understanding of the composing processes and the rhetoric of electronic stories. Virtual reality is discussed briefly as a future stage in interactive fiction's development.

AN UMI Order No. ADG92-09548
AU FIEDLER, KIRK DEAN
TI POSTADOPTIVE INTEGRA-

TION OF INTERORGANIZATIONAL COMPUTER-MEDIATED COMMUNICATION

IN University of Pittsburgh Ph.D.
1991, 158 pages.
SO DAI V52(10), SecA, pp3654.
DE Business Administration, Management. Computer Science. Information Science.

An interorganizational mail system consisting of a series of interconnected computer networks that join thousands of sites worldwide is examined in this study. The study focuses on the process by which an individual accepts and integrates interorganizational mail into the normal way that they communicate: postadoptive integration. This study is based on the premise that the integration of interorganizational mail is the result of the interaction between an individual's perception of the characteristics of the system and his or her intrinsic and extrinsic motivation.

A model was developed and hypotheses proposed that explored how five factors interact and relate to interorganizational electronic mail use. The five variables were: perceived ease of use of the electronic mail system, direct extrinsic motivation, indirect extrinsic motivation, general work related intrinsic motivation, and task specific intrinsic motivation. The integration of electronic mail was operationalized in terms of the user's level of acceptance and routinization of electronic mail.

The model was tested empirically through an electronically delivered survey. A sample was randomly selected from a pool of 45,000 interorganizational users. 549 surveys from twenty different countries were received for an effective response rate of 43.5%. The results of the study revealed that the proposed model is consistent with the data collected.

The final model proposes that direct extrinsic motivation has an effect on ease of use, indirect extrinsic motivation, general work related intrinsic motivation and routinization. Perceived ease of use has an effect on indirect extrinsic motivation, task related intrinsic motivation and routinization. Indirect extrinsic motivation has a strong effect on both acceptance and routinization. General work related intrinsic motivation affects task specific intrinsic motivation. In addition, acceptance has an effect on routinization.

The study has implications both to the general area of information system implementa-

tion and to the management of electronic mail use. The findings also support the value and development of a new electronically-based research methodology.

AN UMI Order No. ADG92-10151
 AU ONGKASUWAN, METTA
 TI AN INVESTIGATION OF THE EFFECTS OF COMPUTER-AIDED SOFTWARE ENGINEERING TOOLS, SYSTEM COMPLEXITY, AND SYSTEM ANALYST'S EXPERIENCE ON SYSTEM DESIGN QUALITY AND PRODUCTIVITY: A LABORATORY EXPERIMENT

IN Georgia State University - College of Business Administration Ph.D. 1991, 244 pages.

SO DAI V52(10), SecA, pp3657.

DE Business Administration, Management. Information Science. Computer Science.

The primary purpose of this research is to investigate the effects of the use of Computer-Aided Software Engineering (CASE) tools on the syntactical quality of the system design specifications and productivity of the syntactic verification tasks. These effects are investigated under varying levels of system complexity and system analyst's experience.

In this research, a controlled laboratory experiment using both non-professional and professional system analysts as subjects was conducted to achieve the primary purpose. Multivariate Analysis of Variance (MANOVA), series of Analysis of Variance (ANOVA), and pair-wise t test were used to quantitatively analyze the experimental data. Protocol analysis of the experimental tasks was used to qualitatively analyze and explain the quantitative results.

The major findings from this study are summarized as follows. First, the use of CASE tool provides lower quality and productivity than traditional tool (paper and pencil). Second, if CASE tool is used as intended by its developer, it provides better quality and productivity than when it is used in the same manner as traditional tool. However, CASE tool still provides lower quality and productivity performance than traditional tool even when it is used as intended. The problem of poor performance of CASE tool seems to lie in the way each feature of CASE tool is used (e.g., difficult to use and connect information). Finally, system complexity and system analyst's experience do not seem to affect the quality and productivity of the use of CASE tool.

AN UMI Order No. ADG92-07303

AU ZACK, MICHAEL H.

TI THE ROLE OF COMPUTER-MEDIATED COMMUNICATION TECHNOLOGY IN ONGOING MANAGEMENT GROUPS

IN Harvard University D.B.A. 1991, 366 pages.

SO DAI V52(10), SecA, pp3662.

DE Business Administration, Management. Information Science.

This research examined the use of computer-mediated communication (CMC) technology within ongoing management groups performing a cooperative task. By means of an in-depth multi-method case study of the senior editorial group of two daily newspapers, the research identified the antecedents to choosing CMC in the presence of alternative modes of communication. It also identified factors influencing how CMC might be used to increase communication effectiveness within the group, leading to effective group outcomes. The study resulted in a normative model of CMC use in ongoing management groups.

Choice of communication mode was influenced by the spatial and temporal proximity of the communicators; their perceived need for a particular level of media richness, channel interactivity, and channel capacity; the perceived reliability and convenience of the communication mode, and the extent to which the search for information was focused and directed.

Creating a shared interpretive context for communication required a rich, interactive channel. CMC was effective when a shared interpretive context was already established, otherwise the richness and interactivity of face-to-face (FTF) was more appropriate. When the communication mode fit the need for richness and interactivity, communication was more effective.

The communication habits and practices of the group set up shared expectations about aspects of communication procedure such as channel, timing, participants, etc. which, when met by group members, resulted in more effective communication.

The study resulted in several normative prescriptions: (1) Communication mode options should be explicitly evaluated by the group and an adequate range of those options made available to the group. (2) CMC systems should be designed to be easy, convenient, and reliable enough so as not to compromise making appropriate mode choices. (3) Managers should explicitly con-

sider their choice of a communication mode based its fit to the particular circumstances surrounding the communication. (4) Group work should be spatially and temporally configured so that FTF can occur easily and efficiently when needed. (5) The group should explicitly discuss its communication habits and practices. (6) Groups should establish and maintain group commitment to open, honest, and clear exchange of information in support of the group's goal, so that appropriate modes of communication will be chosen and effective communication realized.

AN UMI Order No. ADGDX-94800

AU BABER, CHRISTOPHER

TI THE HUMAN FACTORS OF AUTOMATIC SPEECH RECOGNITION IN CONTROL ROOM SYSTEMS

IN Aston University (United Kingdom) Ph.D. 1990, 379 pages.

SO DAI V52(10), SecB, pp5359.

DE Computer Science. Engineering, Industrial.

Available from UMI in association with The British Library.

This thesis addresses the viability of automatic speech recognition for control room systems; with careful system design, automatic speech recognition (ASR) devices can be useful means for human computer interaction in specific types of tasks. These tasks can be defined as complex verbal activities, such as command and control, and can be paired with spatial tasks, such as monitoring, without detriment. It is suggested that ASR use be confined to routine plant operation, as opposed to critical incidents, due to possible problems of stress on the operators' speech.

It is proposed that using ASR will require operators to adapt a commonly used skill to cater for a novel use of speech. Before using the ASR device, new operators will require some form of training. It is shown that a demonstration by an experienced user of the device can lead to superior performance than instructions. Thus, a relatively cheap and very efficient form of operator training can be supplied by demonstration by experienced ASR operators.

From a series of studies into speech based interaction with computers, it is concluded that the interaction be designed to capitalise upon the tendency of operators to use short, succinct, task specific styles of speech.

From studies comparing different types of feedback, it is concluded that operators be

given screen based feedback, rather than auditory feedback, for control room operation. Feedback will take two forms: the use of the ASR device will require recognition feedback, which will be best supplied using text; the performance of a process control task will require task feedback integrated into the mimic display. This latter feedback can be either textual or symbolic, but it is suggested that symbolic feedback will be more beneficial.

Related to both interaction style and feedback is the issue of handling recognition errors. These should be corrected by simple command repetition practices, rather than use error handling dialogues. This method of error correction is held to be non intrusive to primary command and control operations. This thesis also addresses some of the problems of user error in ASR use, and provides a number of recommendations for its reduction.

AN UMI Order No. ADGDX-94992
AU KHAZAEI, BABAK

TI THE DETERMINANTS OF
PROGRAM DESIGNER
BEHAVIOUR: AN EMPIRICAL
STUDY

IN Council for National Academic
Awards (United Kingdom)
Ph.D. 1990, 312 pages.

SO DAI V52(10), SecB, pp5369.

DE Computer Science. Psychology,
Industrial.

Available from UMI in association with
The British Library.

This thesis essentially addresses the problem of understanding the issues that influence program designers during the design stage of a programming task in procedural and logic-based paradigms. In particular, it examines: the shortcomings of the guidelines provided by design methods from a human factor perspective; the methodological issues of conducting empirical research in programming; and the current findings of cognitive models of programming.

The findings of five sets of experimental studies are reported. Experimental studies 1 and 2 raise some issues on the methodological difficulties of conducting protocol analysis for programming. Experimental study 2 provides supporting evidence for a number of behavioural characteristics in cognitive models of programming including incremental design and use of operational thinking. Experimental study 3 raises novel issues in modelling program designer behaviour; in particular it highlights the importance of choice of data representation in approach to

program design. The results of experimental studies 2 and 3 also show that both experienced and in-experienced program designers search for a solution is depth-first rather than breadth-first; but the inexperienced program designers show more urgency to code. Experimental study 4 investigates the sequence of decision making for program construction in logic-based paradigm. It reports on a "carry-over effect" in the change over of programming paradigms. Experimental study 5 provides examples of misconceptions of traditional programmers when constructing programs in logic-based paradigm and further characterises the "carry-over effect". Some observational points on the comparison of programming paradigms are made.

The findings of the experiments and those from cognitive models of programming are used to advance a further model for program designer behaviour. The model is expressed using an operational framework based on the blackboard architecture. The implications of findings for potential programmers are discussed. In particular, a change in emphasis in training as well as the medium for expressing a design solution is highlighted.

AN UMI Order No. ADGNN-61767
AU LIVINGSTON, LORI

TI VIGILANCE FACTORS AND
EYE MOVEMENTS IN
HUMAN-COMPUTER INTER-
ACTION

IN University of Calgary (Canada)
Ph.D. 1990, 166 pages.

SO DAI V52(10), SecA, pp3563.

DE Education, Psychology. Educa-
tion, Technology. Computer Sci-
ence.

IS ISBN: 0-315-61767-5.

The purpose of this thesis was to study vigilance as a factor in human-computer interaction. A popular instructional gaming package, one designed to develop memory and decision making skills, was adapted for this purpose. Traditional measures of vigilance behaviour were used in conjunction with a knowledge of eye movements in an attempt to address the following questions: (1) Can vigilance effects be observed in a prolonged task of human-computer interaction. (2) Can differences in performance on the experimental task be observed under varying colour and/or sound conditions. (3) Can the study of eye movements provide information to assist in the explanation of observed differences in performance.

Following a series of pilot studies, the final investigation was completed in two phases.

The sample consisted of sixty young adults who were randomly assigned to one of six experimental groups which were defined according to their colour and sound characteristics. In phase one, each subject was required to play the game twenty times in succession in order to simulate long-term sustained attention to a computer task. The dependent variables included three measures of performance: the time to completion, the number of plays and the number of four-plus errors per game. For phase two, a high and low performer from each colour condition (n = 6) returned to repeat the experimental task so that eye movement behaviours could be monitored. The type of eye movements, including the mean number and the duration of each, were observed. Patterns of visual search were also noted.

The results of the study offer evidence that performance was best under the black-and-white condition, and least successful under the multicoloured condition. Colour appeared to be a distracting variable. The value of colour as a motivator and/or attention getter, in either a moderately-coloured or multicoloured condition must be questioned.

In terms of the eye movement data, colour appeared to force an increase in the number of eye movements required to complete the task. The better performer under each colour condition typically displayed a fixation time that was greater than that of their low performing counterpart. Differences in mean fixation duration did not, however, appear to vary systematically according to colour condition.

In conclusion, vigilance factors can be identified (i.e. an interaction effect between colour and time) for a simple task of human-computer interaction. Second, the colour complexity of the screen may effect the magnitude of the observed vigilance decrement. Finally, eye movements provide a viable method for studying the nature of human-computer interaction.

AN UMI Order No. ADG92-00771

AU RETTERER, OSCAR JACOB

TI LEARNING FROM A HYPER-
TEXT: THE EFFECT OF
READING INTERACTIVE
TEXT CONTAINING NON-
SEQUENTIAL, ASSOCIATIVE
LINKAGES ON COMPREHEN-
SION

IN The University of Toledo Ph.D.
1991, 179 pages.

SO DAI V52(10), SecA, pp3585.

DE Education, Technology. Informa-

tion Science. Education, Reading. This study was designed to answer three questions: (1) Is there any difference in the level of comprehension when reading a hypertext compared to reading non-hypertext materials?, (2) Do levels of computer anxiety affect comprehension?, and (3) How do individuals react to reading a hypertext.

Thirty-six subjects were randomly assigned to the three groups prior to the experiment. One group (G1) received the experimental treatment, which was a hypertext. One control group (G2) received the same textual information, which was mediated linearly by a computer. The other control group (G3) received a linear text in print format. The three groups were measured on a Cloze test designed to measure reading comprehension. Participants of groups 1 and 2 completed a computer anxiety measure, and a survey assessing perceptions was administered to the experimental group.

The results of a one-way ANOVA clearly show that there was a statistically significant difference. An F statistic of 4.76 ($p = .0153$) resulted in the rejection of the null hypothesis and the conclusion that not all the group means were equal. A Post Hoc test revealed that the group mean of Group 1 (hypertext) was statistically different and greater than the group means of both Group 2 (computer-mediated) and Group 3 (traditional text), and that the group means of Group 2 and Group 3 were not statistically different from each other. Reading a hypertext appears to enhance comprehension as compared to reading nonhypertext materials.

The results of a two-way ANOVA with Group and Anxiety Level as the independent variables, further substantiated by the low correlation coefficient (+0.185), indicate that computer anxiety does not appear to affect comprehension. An F statistic of 1.369 ($p = .2564$) was revealed for levels of computer anxiety indicating no statistical differences between these groups. There was also no AB interaction effect, leading to the conclusion that the effect of the levels of the first independent variable (Group) upon the dependent variable (Cloze) was the same across the levels of the second independent variable (Computer Anxiety).

Finally, the broad spectrum across which the survey responses ranged resulted in no definitive conclusions being drawn regarding user perceptions of the hypertext.

AN UMI Order No. ADG92-04151
AU REED, BILLIE MITCHELL
TI A ROBUST APPROACH TO
HUMAN-COMPUTER INTER-

FACE DESIGN USING THE
TAGUCHI METHOD
IN Old Dominion University Ph.D.
1991, 195 pages.
SO DAI V52(10), SecB, pp5515.
DE Engineering, System Science.
Computer Science. Engineering,
Electronics and Electrical.

The application of Dr. Genichi Taguchi's approach for design optimization, called Robust Design, to the design of human-computer interface software is investigated. The Taguchi Method is used to select a near optimum set of interface design alternatives to improve user acceptance of the resulting interface software product with minimum sensitivity to uncontrollable noise caused by human behavioral characteristics.

Design alternatives for interaction with personal micro-computers are identified. Several important and representative alternatives are chosen as design parameters for the Taguchi matrix experiment. A noise field with three human behavioral characteristics as noise factors were chosen as a representative noise array. Task accomplishment scenarios were developed for demonstration of the design parameters on an interactive human-computer interface. Experimentation was conducted using selected human subjects to study the effect of the various settings of the design parameters on user acceptance of the interface. Using the results of the matrix experiment, a near optimum set of design parameter values was selected.

A verification experiment was developed and performed using the predicted near optimum design parameter values. Analysis of the follow-up experiment indicated improved levels of user acceptance with the near optimum values.

This study suggests that the Taguchi Method of design optimization is applicable to human-machine engineering in general, and to the design of human-computer interface software in particular, as a means of selecting a near optimum set of design alternatives. This methodology is useful in reducing the number of total experiments required for optimization where several design alternatives exist in a richly interdependent context.

AN UMI Order No. ADG92-08603
AU LOHSE, GERALD LEE
TI A COGNITIVE MODEL FOR
UNDERSTANDING GRAPHICAL PERCEPTION
IN The University of Michigan Ph.D.
1991, 291 pages.
SO DAI V52(10), SecA, pp3464.

DE Information Science. Computer Science. Psychology, Experimental. New advances in animation, scientific visualization, and graphical user interfaces make it essential that graphic design have advice about how to provide interfaces that mesh with users capabilities. The purpose of the dissertation is to gather what we know from cognitive psychology about graphical perception and put it in a computer program useful for designers of graphical displays.

A computer program, UCIE (an acronym for Understanding Cognitive Information Engineering), simulates the mechanisms that underlie graphical perception. UCIE predicts the time it will take someone to answer a question from a graph or table. UCIE assumes the viewer follows a logical path of eye movements, called a semantic trace, to retrieve information from the graphical display. UCIE predicts total time by adding the times from the individual perceptual and cognitive components. Graph type and question type determine which component tasks are involved. UCIE moves beyond the current level of understanding by providing more detail about potential interactions among the component tasks in visual perception and cognition.

UCIE has undergone rigorous empirical verification. Reaction times to yes/no questions have been gathered from 28 subjects. Each subject participated in eight replications, viewing three kinds of graphs (bar, line and tables), each with and without color and grid lines, answering three types of questions (point reading, comparisons, and trends) with two levels of difficulty. The largest predictive component is the number of fixations, explaining 31 percent of the variation by itself. Overall, UCIE explains about 37 of the variation in reaction times.

Graphics reduce cognitive overhead and enable people to perform certain tasks that would be more difficult, if not impossible, when the knowledge contained in the graphic was structured in a different format. The second study assesses decision making performance using a simulated business task with three levels of task complexity and two levels of quality of a graphic decision aid. The results suggest that the quality of the graphic decision aid influences performance only when the task is very complex.

The explanatory power of UCIE can be exploited in several practical applications. The graphical perception and cognition "core" of UCIE can be a prototype for the analysis of more complex displays such as those for CASE tools, nuclear control rooms and cockpit design.

AN UMI Order No. ADG92-12272
AU DIEFENBACH, THOMAS WIL-
HELM
TI THE EFFECT OF VERBAL
MESSAGES ON USER
FRIENDLINESS: AN EMPIRI-
CAL INVESTIGATION USING
AN INTELLIGENT TUTOR-
ING SYSTEM
IN The Florida State University Ph.D.
1991, 127 pages.
SO DAI V52(11), SecB, pp5926.
DE Computer Science. Psychology,
Experimental. Artificial Intelli-
gence.
Today's user interaction is limited to a
sophisticated visual interaction even though

humans are naturally geared to use their
visual as well as their oral senses in parallel.
This leads to the assumption that speech
output as one of the possible forms of audio
communication has the potential to
enhance the user friendliness and thus, the
over-all quality of suitable software applica-
tions.

An empirical study was conducted to com-
pare the user friendliness and the level of
motivation for two treatment groups. Both
groups had to solve arithmetic word prob-
lems using the Intelligent Tutoring System
TAPS implemented on the NeXT Machine.
The control group received all the messages
in the conventional visual form whereas the

treatment group obtained all messages ver-
bally. All other factors were controlled in
both groups.

The results of the statistical analysis of the
subjects' self-test and the observations, vali-
dated the assumption that verbal messages
have a significant effect on enhancing the
user interaction. Speech output allows for a
more natural communication and has the
potential to result in a more effective inter-
action. An application is easier to learn and
easier to use when verbal messages are
embodied into a user interface. Additionally,
users receiving messages verbally are more
motivated to work with the system which
enhances user friendliness even further.