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Measuring the Effectiveness of Hypertext In Decision Support

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ABSTRACT

Hypertext is an emerging technology that has not been researched adequately, particularly in organizations that utilize decision support technologies. This paper suggests that developing a set of dependent variables to measure effectiveness of hypertext in decision support is an important first step in a program of research. A review of empirical hypertext research is presented followed by a discussion of research assessing effectiveness of decision support and related systems. The role of hypertext in organizations is conceptually linked to the three main phases of the decision making process: problem structuring, analysis, and problem resolution. A set of six classes of appropriate dependent variables for assessing effectiveness of hypertext is suggested within the context of the decision making phases: information content and function variables are associated with problem structuring; presentation and usage variables are associated with analysis; outcome and perception variables are associated with problem resolution.

INTRODUCTION

Hypertext as a field of study has begun to generate great interest. Emerging technologies and technological change seem to be the standard within the information systems discipline. A number of important frameworks have been proposed (e.g., [10], [33], [46], [20], [38], [51], [18], [5], [39]) to guide researchers in their quest for an understanding of how decision makers utilize information systems and the consequences of systems on behavior. A compelling question is often raised by managers: how effective is the technology in supporting the decision maker? With the advent of an emerging technology such as hypertext, having potentially valuable decision support features, researchers must be able to measure the effectiveness of the resource. The purpose of this paper is to suggest an initial set of dependent variables to be used in a comprehensive program of research.

The first section briefly defines hypertext and reviews hypertext usage and research in a DSS, providing a basis for understanding the dependent variables that could be used for assessment. The topic of effectiveness measurement is then discussed with an emphasis on the process of decision making involving problem structuring, analysis, and resolution. Next a model is proposed for addressing the problem of measuring the effectiveness of hypertext. A following section proposes a set of dependent variables in the context of decision making support that could facilitate a research program on hypertext effectiveness. Finally, the potential of future hypertext research is addressed.

HYPERTEXT USAGE AND RESEARCH IN DSS

Hypertext systems consist of computer-implemented networks of nodes (database objects, normally text) and links (arcs used to traverse between nodes). They are by far the most prevalent subset of hypermedia systems, the latter systems also incorporating nodes which may contain other media representations such as audio and video information. In hypertext systems the database objects are collections of text which are most often displayed to the user as screen windows. Links between the objects appear to the user as selectable tokens (also called buttons or link icons), forming anchors in source and destination nodes and corresponding to pointers in the database. Links are activated by selecting a link icon through the use of a pointing device such as a mouse or a touchscreen. The operationalization of machine-supported links allowing traversal of a non-linear network of nodes is central to the hypertext paradigm. Hypertext appears to the user as a system of imbedded menus (as opposed to explicit menus) that allows selection of items in context within a current window for further investigation or manipulation [22].

For readers wishing to review existing research concerning hypertext, the following sources would be valuable. An introduction and survey of hypertext can be found in [4] (and, in more detail, in [3]). A survey of hypermedia applications in academia appears in [1]. Hypertext and hypermedia bibliographies include [8], [24], and [50]. Discussion of application and research areas involving hypertext in decision support systems (DSS) can be found in [35] and [36].

Hypertext employs information and knowledge management techniques appropriate for organization-wide use. It may be used to facilitate several important functions of decision support, including: (1) assisting in problem exploration and the initial formulation and structuring of problems; (2) aiding information gathering and structuring in support of problem analysis; and (3) supporting problem resolution. Major usage of hypertext technology, however, generally has not been associated with DSS. Rather, applications have focused primarily on browsing of textual databases for exploration and

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information retrieval. Usually these hypertext databases are browsed in one of four modes: (1) spontaneously and iteratively by choosing any desired link from the present node; (2) in a directed manner by following a pre-defined path through the network; (3) in search mode by invoking a mechanism to locate a node having some desired characteristic; and (4) in quasi-direct access mode by viewing a graphical browser which displays a visual representation of all or part of the network and allows the user to select a node to visit. In addition to browsing of textual databases existing hypertext systems commonly have been used in three other ways [4]: (1) as macro literary systems supporting on-line collaborative writing; (2) as problem exploration tools such as outliners; and (3) as general experimental vehicles most often related to textual applications.

As hypertext systems become increasingly used, the measurement of their effectiveness will assume increased importance as well. Yet research into their effectiveness has not been forthcoming despite the surge in hypertext-related research and applications. For instance, an examination of a recent hypertext bibliography [24] reveals over 350 related research works but only a handful involving empirical research. Furthermore, the existing empirical studies have investigated only a small percentage of worthy questions. Six recent studies reported in the literature are summarized in the Appendix, which lists the task, independent and dependent variables, and major findings of each. While this sample is not claimed to be exhaustive, it is representative of most current empirical hypermedia research. These studies are characterized by: (1) their single-user mode; (2) tasks involving primarily information retrieval from a static database; (3) independent variables chosen to allow comparisons of hypertext embedded menus against other user interfaces such as explicit menus, page turning commands, manual or computerized indices, formal query languages, as well as manual search of paper documents; and (4) dependent variables largely oriented toward search speed, accuracy, efficiency, and user preference.

EFFECTIVENESS MEASUREMENT IN A DSS ENVIRONMENT

Ultimately organizations are concerned about the effectiveness of those resources utilized to support decision making activities. Unfortunately, there has been little research dealing with the issue of measuring effectiveness of decision support systems. In part, the lack of research may be attributable to the difficult problem of operationally defining effectiveness. However, the greater problem in measuring effectiveness simply may be the extensive number of dependent variables utilized in a wide variety of research settings.

Prior Work

There is a well recognized body of literature which establishes a theoretical basis for defining effectiveness of information systems usage such as DSS (see for example [38]). Several researchers have focused their efforts on measuring the success of DSS implementation. A distinction between organizational and individual level of success should be made [44]. Liang [27] empirically determined that DSS quality as well as the representation format of information were critical to individual success. Sanders and Courtney [45] in a field study showed that DSS success partially could be assessed by the decision maker's satisfaction with the system. This notion of satisfying the end-user even in the selection of the type of DSS software that will be employed is important for success [43].

Three major areas have been researched which are related to DSS effectiveness: (1) problem formulation and structuring; (2) problem analysis, including information retrieval; and (3) problem resolution and decision making. The effectiveness of the process of decision making is beyond the scope of this paper, although the decision making process is of central importance to DSS and has received great attention by behavioral decision making researchers [17], [29]. Problem formulation involves the identification of relevant variables through information gathering and the process of structuring relationships among variables. Individual differences such as cognitive processes are important in problem formulation [42], although decision maker personality has been shown not to have an impact on decision maker behavior [34]. DSS support of problem structuring also may be affected by organizational context such as the difference between public and private sector [16]. Model management systems have been suggested as a mechanism for supporting problem formulation because the high expectations for decision maker involvement with the DSS have been disappointing [7]. In a recent project Pracht and Courtney [41] empirically demonstrated that problem structuring tools interact with individual differences and offer promise as a means for enhancing the effectiveness of DSS.

Considerable research interest exists about the information utilized in decision making with a DSS. Decision makers may not know what information they will need and often are unable to specify what they want or request far too much detail [14]. However, decision makers will perform better if they have an opportunity to select the information they desire rather than being provided with static reports [2]. In fact, executives require all types of media and do not rely very much on computer based information systems to support decision making [19]. Knowledge workers will need more than just data base support; they will need text processing, graphics processing, calculation, and other forms of information [28]. One other type of information is a knowledge base which will become more important as DSS and expert systems (ES) begin to merge [15]. The concept of a manager's perception of their decision environment empirically has been shown to play a role in the complexity and use of information in problem formulation and decision making [47]. Information should be tailored to groups of people based on their common perception and preferences for information [48]. Aside from presentation of information there is the issue of the amount of

information that can be processed which may lead to information overload [9].

Three major observations may be made about the prior work on measuring DSS effectiveness. First, individual perceptions about DSS usage, particularly satisfaction with the system, are important. Second, there is strong support for utilizing the three major phases of decision making processes as a context for investigation. Third, the manner by which a decision maker utilizes information plays an important role.

Issues in Conducting Research on Effectiveness

There are a number of research issues which make the task of determining DSS effectiveness difficult. Prominent among these is the problem that direct dependent variables are utilized only infrequently. Effectiveness of DSS usage typically is measured by the surrogate variables of decision performance such as time to make a decision, number of alternatives considered, number of DSS features utilized, decision maker satisfaction, decision maker confidence, and so on [11], [27], [13]. Information access and manipulation is essential to support DSS activities. Yet the complexity of the task will impact upon the need for information as well as the problem finding and solving capabilities of the support system. Furthermore, as Philippakis and Green [39] posit, there are several types of DSS for both individual and group decision making which have different resource requirements and productivity implications.

Environmental complexity alone is a formidable barrier to research. Focus on the decision maker for determining DSS effectiveness would seem to be the most fruitful approach: "In the final analysis, it is not the software or the hardware that makes a DSS effective but the people who actually use (or misuse) it" ([43], p. 179). Providing the decision maker with the type and format of information or knowledge required by a given problem has been shown to be instrumental in problem solving. Herein lies the potential of hypertext and hypermedia to provide for more effective utilization of DSS to support decision making.

MEASURING EFFECTIVENESS OF HYPERTEXT

Effectiveness of a new technology, such as hypertext, is relatively simple to define, but very difficult to measure. For example, effectiveness is the ability to deploy resources to best meet organizational objectives. But how does one go about measuring how well a hypertext system meets the organizational objectives of improved decision making? This question poses a significant challenge for researchers with important implications for practitioners: the establishment of a set of dependent variables to measure effectiveness of hypertext in the support of decision making.

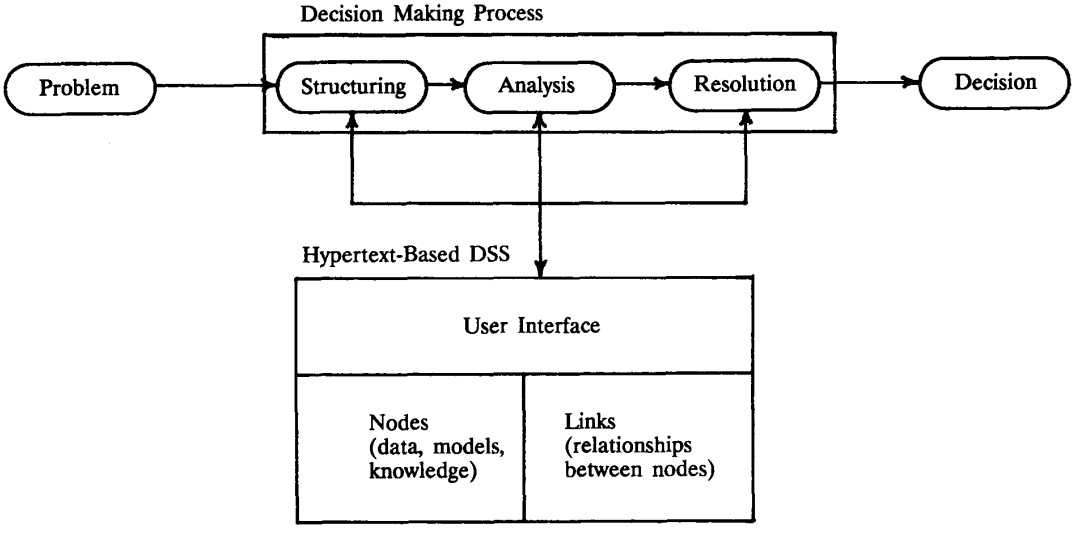

Figure 1
Hypertext in Support of Decision Making

A systematic and consistent program of research is required to address the effectiveness of emerging technologies such as hypertext. Rather than defining ad-hoc research paradigms for each particular technology, a set of functional needs associated with users of technology should be identified. Only after this is accomplished should the existence and extent of support for those needs provided by a particular technology be investigated. The application of this method of technologically-independent criteria applied to technologically-specific situations is well suited to hypertext effectiveness measurement.

Figure 1 shows the relationship between the decision maker and the employment of hypertext technology through a DSS. The decision making process consists of three phases: problem structuring, analysis, and resolution. These phases synthesize the work in [46], [47], and [12]. The process of decision making is assisted by a hypertext-based DSS consisting of a user interface linked to an integrated network of nodes (data, knowledge, and models) and links (relationships between nodes).

The three phases of decision making shown in Figure 1 provide a strong theoretical basis for investigating the effectiveness of technology such as hypertext. Theoretical support exists for the process of problem structuring [12], [47], [37]. DSS are purported to facilitate structuring by allowing the decision maker to interact with the DSS in tasks such as reducing the problem to less complex sets. Hypertext can support this activity by allowing the user to browse available information in search of relevant concepts or variables, and then allowing the user to establish links and relationships between them. For example, cognitive mapping [23] is useful for problem structuring and implementable using hypertext. The issue of organizational context in a DSS as suggested by [9] may be addressed by the use of hypertext to assist in problem structuring. Environmental scanning, links to external information sources, and information filtering are other problem structuring facilities which may be operationalized through the use of rule-based agents acting on behalf of users [30].

The analysis stage of decision making can employ hypertext to both present and manipulate problem elements and their relationships. A simple illustration is the "information hiding" capability of hypertext which allows varying levels of detail to be displayed. For example, hierarchically organized blueprints of buildings may contain levels of detail corresponding to the entire structure, individual floors, office suites, individual offices, etc. Thus the user may view a macro representation of the problem to control cognitive complexity, yet "drill down" to examine more detail of any element.

Assistance in problem analysis also is provided in cognitive mapping systems where the user can simulate various scenarios and perform sensitivity analysis by manipulating nodes and links in the network. A common cognitive mapping approach is to represent quantitative variables as nodes, with negative or positive relationships between them as links. In this way the user can analyze the effect of an increase or decrease in an input variable as it affects other variables in the system.

Hypertext may assist in the resolution of problems during the behavioral process of decision making. Convenient information retrieval facilities may decrease the time needed to reach a decision. Direct manipulation capabilities provide an environment that can enhance decision makers' confidence in decisions made and satisfaction with a DSS. On an individual level a user may establish a number of solution scenarios as hypertext sub-networks for rapid comparison with candidate solutions. On a group level this allows a dialectical approach to choosing and justifying a solution by making explicit the assumptions used [32].

A set of dependent variables for measuring the effectiveness of hypertext should be defined in the context of the three phases of decision making. The user interface, linked to an integrated network of nodes and links provides a basis for understanding how decision makers may employ hypertext. Thus, the mechanisms for using hypertext may in part help to explain how hypertext is supporting various aspects of the decision process.

DEPENDENT VARIABLES

Within the context of the decision making process in a DSS environment, Table 1 displays a comprehensive set of six categories of variables to assess the effectiveness of hypertext. Effectiveness of hypertext support for problem structuring may be measured by two categories of variables classified as information content and function. Information content refers to the effectiveness of hypertext in delivering information that would support the decision maker in problem formulation. Function is the particular facility of hypertext that may be utilized by the decision maker in structuring a problem. Assessment of hypertext in the analysis stage of decision making involves presentation and usage variables. Presentation refers to particular features of hypertext used to present information to the decision maker. The usage category includes the number and extent of hypertext support facilities used by the decision maker. Problem resolution is measured by both objective outcome variables and subjective perception variables. Outcome variables include quality, objective value, and efficiency of the resolution process. Each may be measured with surrogate variables such as decision correctness, economic value, and time taken to reach a solution, respectively. Perception variables relate to subjective and affective characteristics of users such as their confidence in solutions, perceived value of solutions, and satisfaction with problem resolution. This set of variables is not intended to be exhaustive, but rather represents an initial but systematic set of candidate variables.

Information Content Variables

Information content variables address the issue of effectiveness of hypertext in supporting various levels

Problem Structuring		Problem Analysis		Problem Resolution	
Information Content	Function	Presentation	Usage	Outcome	Perception
Knowledge	Learning	Mode	Frequency	Quality	Confidence
Text	Communicating	Quantity	Duration	Objective value	Perceived value
Data	Modeling	Form	Pattern	Efficiency	Satisfaction

Table 1
Dependent Variables for Measuring Effectiveness of Hypertext

of information requirements of decision makers. The most abstract level of information, the semantic knowledge level, is also the most powerful kind of information for structuring and representing problems. For example, this kind of knowledge might embody a firm's strategic assumptions or predictions about the future. Assessment of hypertext in providing knowledge to a decision maker may take place in a variety of ways. Researchers could utilize automated process tracing to determine the type and extent of access to the knowledge base and to link the access to the structuring stage of decision making. Elicitation of decision makers use of knowledge level in structuring could be of great value. Instrumentation could be developed to subjectively evaluate the contribution of the knowledge level variable to the structuring process of problem formulation. The users' techniques in manipulating semantically significant links between concepts in hypertext may itself be a capturable and important measure of information utilization.

Hypertext permits the access of text and text-like material. The text level variable would permit a decision maker to access supporting material in the attempt to structure a problem. A comparison of the number of text retrievals to other types of retrievals may offer insight into the structuredness and/or structurability of the problem. Text nodes also provide the opportunity to link annotations to other nodes which relate to the problem solving process and might be used for both personal and communicative purposes.

The data level is the most elementary form of information support for decision making. Hypertext interfaces are most suitable to the knowledge and text levels of information retrieval but also can support the data level. As with text data, some questions of whether hypertext is effectively utilized by a decision maker in structuring problems partially may be addressed by the frequency and purpose of data level retrieval.

Function Variables

Decision makers may select a specific facility of hypertext such as browsing, assimilating, and information retrieval to assist in formulating a problem. Usage of these facilities may be observed by tracing, instrumentation, subjective reporting, and other methods. The particular facilities used, however, are merely manifestations of underlying functional needs and problem structuring strategies employed by the user. Browsing represents the decision maker searching for bounds to a problem or perhaps even problem finding. Assimilating information from various sources allows the user to link together items which they find useful into more easily managed personal semantic networks if desired. Re-visiting a previously visited node may indicate a focusing of the decision maker's attention on a particular aspect of the problem.

The underlying functions which manifest themselves as surface-level behaviors include the functions of learning, communicating, and modeling. Learning is an important function well supported by hypertext as decision makers may conveniently access information in a variety of modes and at various levels of detail required to learn more about a particular subject or situation. Several forms of learning, including learning from examples, learning by analogy, and learning by investigating causal relationships, may be supported with hypertext. The type and extent of hypertext learning support are important dependent variables to explore.

The communicating function is an often-overlooked hypertext capability which may be utilized for one decision maker to communicate with others who might also be involved in the decision process such as in group decision support systems (GDSS). Hypertext facilitates communication involving all its component elements, including knowledge, text, and expressed relationships. Unlike many computer-assisted communication paradigms, hypertext supports automatic,

passive, asynchronous communication as a side effect of users updating the network. This allows convenient collection of a rich historical record of the communication process which includes more than just its artifacts (messages). It would seem reasonable to speculate that hypertext should prove to be an effective tool for communicating in a group decision environment. Appropriate dependent variables might include the mode (asynchronous versus synchronous) and other characteristics of communication best supported by hypertext.

The modeling variable should measure the frequency and extent of model access through hypertext in formulating problems and problem subsets. Model management systems have been suggested [25] to assist decision makers with selection of appropriate models for solving given problem types. Network-based model management systems (e.g., [26]) have a natural isomorphism with hypertext and allow process tracing methods to record the number, type, and sequence of modeling operations chosen and executed. Research should concentrate on basic modeling functions and the types most successfully and extensively used with hypertext.

Presentation Variables

Information must be presented to decision makers in an effective manner. Perhaps more research has been conducted on the presentation of information than other hypertext support functions. As shown in the Appendix, most hypertext-related research in this area has centered on variables such as embedded versus explicit menus or page-turning commands and electronic versus paper representations for information retrieval tasks. However, it is our contention that these variables do not adequately address effectiveness of information presentation for decision support. We suggest that presentation variables include generic classes of variables such as the mode of information presentation (e.g., media used), the amount (and level of detail) of information presented, and the form in which it is presented (tables, graphs, etc.) in the context of decision making activities.

Usage Variables

Measuring the usage of technology such as hypertext in the analysis of problems is another area where surrogate variables are often employed in an attempt to gain insight into the underlying decision process. Some of these variables associated with usage include frequency of accessing hypertext facilities during problem analysis, node visitation frequency and duration, and self reporting on usage. Patterns of usage may be a function of the type of problem and be related to other dependent variables. Research efforts should attempt to clarify both how decision makers are utilizing the hypertext interface itself and the effectiveness of the underlying hypertext network representation for DSS analysis. Important variables include the frequency, duration, and patterns of use in a decision making (not just information retrieval) environment.

Outcome Variables

Some variables related to technologically assisted problem resolution may be objectively measured in some circumstances (these are referred to as outcome variables in Table 1). For instance, the quality of decisions made in some environments might be shown by subsequent analysis or data collection to be optimal versus sub-optimal, correct versus incorrect, etc. Similarly, in some cases the value of solutions may be reflected in a firm's return on assets or other financial statistics. Finally, the efficiency of the process itself may be measurable. For instance, if time to reach a decision were associated with the effective deployment of a decision maker resource, then time as a variable should be considered.

Perception Variables

Other variables, referred to as perception variables in Table 1, relate more to a decision maker's affective perceptions than objective results. Individual differences in the process of problem resolution have been studied widely in referent disciplines such as behavioral decision making [29], and may affect these perceptions. Decision maker confidence, as assessed by self report, could be of value in assessing hypertext interface with DSS in problem resolution. Perceived value of the technological support and user satisfaction in resolving problems likewise would be appropriate variables to incorporate in assessment. Perception variables are as important as objective outcome variables in measuring effectiveness for at least two reasons: (1) they affect the user's willingness to use the technology; and (2) marked differences between parallel subjective and objective measures may indicate inappropriate use of the technology or a lack of user understanding.

CONCLUSIONS

Measuring the effectiveness of emerging technologies such as hypertext possess formidable research problems. These research problems partially may be resolved with carefully constructed designs and well executed studies. However, some problems are inherent in the development of new research arenas. One such problem for researchers is a benchmark concept so that results of various studies may be comparable. Standardization of treatment effects would be most helpful in permitting comparisons of research. For example, the research field of hypertext technology currently does not have a standardized, replicatable case exercise that could be employed as a treatment in addressing a wide range of hypertext questions. Clearly, this issue should be resolved.

Another important problem area for establishing a program of hypertext research is the development of a set of dependent measures to assess effectiveness. The thrust of this paper has been to provide such a set

of dependent variables. Independent variables rarely, if ever, pose serious problems in conducting research. Of major concern in assessing decision making is the ability to study a process that is cognitive and largely incapable of direct observation. Therefore, selection of dependent variables that would be used to assess treatment effects must be made with great care. Too often researchers are tempted to employ trivial dependent measures for convenience partly due to a lack of clearly defined and previously established dependent variables. With emerging decision support technologies proliferating, it is essential to define a set of dependent variables that could facilitate a program of research. It is within this spirit that researchers will be able to piece together a better understanding of how decision makers may effectively utilize hypertext from diverse studies that will have a common referent base of related dependent measures.

Organizational context is an important research issue. The architecture proposed by Philippakis and Green [39] raises some important hypertext research questions. For example, the organizational scope of the problem (operational or strategic), the degree of systems formality (ad hoc or institutional), and the decision making mode (individual or group) may have different effects on hypertext usage. Furthermore, the decision maker may utilize hypertext differently depending upon the stage of the decision making process as well as the complexity of the problem. The suggested set of dependent variables could help to formulate a relationship between the context of the problem and the decision making process.

Problem structuring will continue to be an important area of study. Decision makers gradually will incorporate new technologies such as hypertext in the process of formulating problems. Effective training methods for new paradigms such as hypertext training may prove to be a worthwhile area for research, particularly for decision makers who may need to learn how to use these paradigms to formulate problems. Hypertext offers opportunities to decision makers for reducing complexity and assisting in problem structuring.

As hypertext technology evolves decision makers also will encounter hypermedia systems and other related technologies. It is crucial that we recognize that decision makers in all professions are faced with increasingly complex problems and a plethora of new technologies to solve them. The implications to organizations who invest in this technology are quite clear: research must be undertaken to learn how to more effectively use decision support technology. The alternative is the unpleasant possibility that sophisticated tools will be developed without knowledge of their effectiveness and without decision makers fully utilizing their capabilities.

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APPENDIX: Summary of Selected Empirical Hypertext Research

STUDY	TASK	INDEPENDENT VARIABLES	DEPENDENT VARIABLES	RESULTS
[Powe85] (as reported in [Kove86]). Within subjects design. Hyperties software.	Searching for answers to predefined questions in a TIES (The Interactive Encyclopedia Systems) hypertext database	Embedded versus explicit menus	Number of correct answers within fixed time limit	Embedded menus resulted in a higher number of correct answers
			Number of screens viewed	Embedded menus resulted in a lower number of screens viewed
			Subject preference	Subjects preferred embedded menus
[Kove85], [Weid85] (as reported in [Kove86]). Between subjects design.	"Problem solving" using on-line manuals	Embedded menus versus page-turning commands to access manual pages	Time taken to solve problems	Embedded menus resulted in ⇒ wer problem solving performance
			Number of pages viewed per problem solved	Embedded menus resulted in more pages viewed per problem solved
			Subject preference	Subjects preferred embedded menus
[Kove85] (as reported in [Kove86]). Within subjects design.	"Problem solving" using on-line manuals	Embedded menus in conjunction with database search pruning versus paper manuals	Time taken to solve problems	Embedded menus with pruning technique resulted in faster problem solving (more than twice as fast)
			Number of pages viewed per problem solved	Embedded menus with pruning technique resulted in fewer pages viewed
			Time spent viewing each page	Embedded menus with pruning technique resulted in less time viewing each page
[Egan89]. Between subjects design. SuperBook structured browsing system software.	Various tasks involving searching the SuperBook electronic version and paper versions of a statistics text	Electronic versus paper version of text and others	Search accuracy	SuperBook use generally resulted in higher accuracy
			Search speed	Mixed depending on presence of text-word and heading-word cues.
			Scores on open-book essay questions	SuperBook users scored significantly higher than paper text users
			Subject ease-of-use rating	SuperBook users rated documentation easier to use
[Marc88]–summary of selected Hyperties research	Use of Hyperties for factual information retrieval and browsing	Specific factual information retrieval versus browsing	Use of embedded menus or alphabetical indices	Embedded menus used more for browsing; indices used more for specific fact retrieval
		Embedded menus versus alphabetical indices	Speed of fact retrieval	Index users were faster initially, but gap narrowed with experience using embedded menus
[Marc88]–summary of selected Grollier's Electronic Encyclopedia on CD-ROM research	Searching a 60 megabyte on-line encyclopedia	Low cognitive load strategies supported by hypertext versus analytical, higher cognitive load strategies supported by Boolean database queries	Search efficiency in terms of time and number of keystrokes	Analytical approach slightly more efficient than low cognitive load strategies
			Search effectiveness (success in finding information and quality of essays produced)	No significant differences