

## USING INFORMATION FROM EXTERNAL DATABASES: CONTEXTUAL RELATIONSHIPS OF USE, ACCESS METHOD, TASK, DATABASE TYPE, ORGANIZATIONAL DIFFERENCES, AND OUTCOMES

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**Abstract**—This study applies theories about organizational information processing and about valuing information to better understand the influences on method of access and on effects of using online information. Interviews in four organizations indicated that users manage such systems in different ways suitable to the organization's problem-solving needs and personnel skills, in order to obtain considerable benefits and overcome some problems. Questionnaire data showed that type of database and organizational differences strongly influenced access method, but access method had no independent influence on usage or on perceived outcomes. Counter to expectations based upon the difficulties in assessing the cost/benefit ratio of information obtained from external sources, task variables had little independent influence on access method, usage, or outcomes. The moderate relationship between using online information in one's work and the two outcome factors seems generalizable across organizations. Differences in tasks, especially amount of information in one's task, appeared to influence the relationship between use and outcomes.

### SYSTEMS, ENVIRONMENTS, AND INFORMATION PROCESSING

Huber (1984) and others have argued that organizational environments are becoming more complex, partly through the shift from an industrial to an information-based economy (Bell, 1973; Machlup, 1962; Porat, 1978). Organizational environments have been defined as the "information which becomes available to the organization or to which the organization, via search activity, may get access" (Dill, 1962, p. 96). The ability of an organization to realize its goals depends on how well the organization acquires, interprets, synthesizes, evaluates, and understands this information, and how well its information channels support these processes (Aldrich & Herker, 1977; Ewusi-Mensah, 1981; Galbraith, 1977). Thus organizations must scan the environment, develop interorganizational relations, and obtain external information (Adams, 1980). Organizations have turned to computing and telecommunications systems, including online external databases, to help manage these changing information processing requirements across organizational boundaries (Barret & Konsynski, 1982; Culnan, 1983b; Ewusi-Mensah, 1981; Huber, 1984). For example, Table 1 suggests how using online external databases may alter both external relations and internal operations.

Online databases can provide bibliographic references and abstracts, numeric data such as econometric time series or companies' financial status, or the full text of articles and reports (Regazzi, Bennion, & Roberts, 1980; Sieck, 1984; Wanger & Landau, 1980). External commercial database vendors and online services provide these databases through leased lines and packet-switched value-added computer networks.

There are over 3700 publicly available online databases in the United States, developed by over 1600 database producers, and accessible through more than 550 online services over

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Table 1. Potential changes from using online databases, by nature of outcome and realm of application

Nature of outcome	Realm of application	
	Competitive marketplace	Internal operations
Structural change	Entry into new financial markets Early response to other medical, technical research	Search intermediaries become information gatekeepers Increased boundary-spanning
Products and processes	Large legal firms gain economies of scale in tracking case precedents and performing patent searches Compare patient history to wider baseline data	Avoid redundant or failed research; Provide automatic updated environmental scanning Shift from searching for and reading full articles to scanning abstracts

Based upon Benjamin, Rockart, Scott-Morton, and Wyman's (1984) Strategic Opportunities Matrix.

a variety of telecommunication networks (Cuadra Associates, 1988). Since 1979, the number of databases available has increased yearly by 37% (Cuadra Associates, 1988; Information Today, 1987). Online usage increased by 27% between 1982 and 1983, from 1.25 million to 1.59 million hours (Williams, 1985), and represented over two million users in 1987 (Information Today, 1987). In 1986 the commercial online database industry represented a \$1.6 billion market (Field & Harris, 1986).

Thus, due to the increasing complexity of organizational environments and the development of new information systems, the extent to which use of online information can improve one's work performance is an important research focus.

Yet, as many theorists of the information society emphasize, information is a very different entity from material goods (Machlup, 1962). Users cannot easily determine its value until they actually have or use it, because its value depends upon the particular context, and is relative to the needs of the particular user. Indeed, many studies of information systems rely on perceptual measures of user satisfaction and system success precisely because it is so difficult to justify "objective" measures, and because users' attitudes and evaluations are for many purposes the only meaningful criteria (Ives, Olson, & Baroudi, 1983; Lucas, 1981). Thus the value of information is difficult to determine in advance (Hall, 1981; Johnson and Rice, 1987, pp. 28-29; O'Reilly, 1982). Therefore, many factors can moderate relationships among requiring information, using it, and evaluating its benefits (Rice, 1987). In particular, how one accesses the system, what one's tasks are, what kinds of databases one uses, and the problem-solving needs of one's organization, should represent some of the central influences on one's ability to evaluate information.

The present research is motivated by this underlying concept of the basic difficulty and contextuality in evaluating information. Might this very pervasive fact of the contextuality and difficulty in evaluating information be used to help explain and predict the contingent influence of several factors in the process of using online information and assessing its outcomes? Based on this underlying uncertain nature of information's value, the present research tests several hypotheses about the possible contingent influences of (a) the method of accessing external online databases, (b) task characteristics and information processing requirements, and (c) type of database, on perceived improvements in task performance associated with use of information obtained from those databases. It also explores several research questions about the extent to which organizational differences also influence these variables, what are some positive and negative outcomes from using online commercial databases, and how those outcomes were managed in four organizations. Thus this study uses qualitative and quantitative analyses, motivated by the theoretical problem of evaluating information, to better understand the use and outcomes of external online database information.

THEORETICAL BACKGROUND AND HYPOTHESES

*Use of online information and changes in work*

Research on computer information and communication systems has found that greater use of these technologies is often associated with improved availability of information, productivity, quality of work, and effectiveness and efficiency in accomplishing tasks (Hiltz & Johnson, 1989; Rice & Associates, 1984, pp. 211-213). However, these same systems may also contribute to the very complexity they are intended to reduce (Beniger, 1986; Huber, 1984), by providing more choices about organizational processing technologies, changing internal structures and members' roles, and generating greater amounts of information to process.

**HYPOTHESIS IA (H1a)**

*Users of online information will report improvements in their work performance.*

**HYPOTHESIS IB (H1b)**

*Use of information from online databases in one's work will be positively related to perceived improvements in work performance.*

**ROGATORY QI (RQ1)**

*How has the use of online external databases been associated with other improvements and problems in organizational structures, roles, and task performance, in different organizations?*

*Contextual and contingent influences*

*Overview.* The present research focuses on four basic contexts for evaluating information, and thus should influence the relationship between use of online information and perceived changes in performance: (1) access method, (2) database type, (3) task characteristics and information processing requirements, and (4) organizational differences (see Fig. 1).

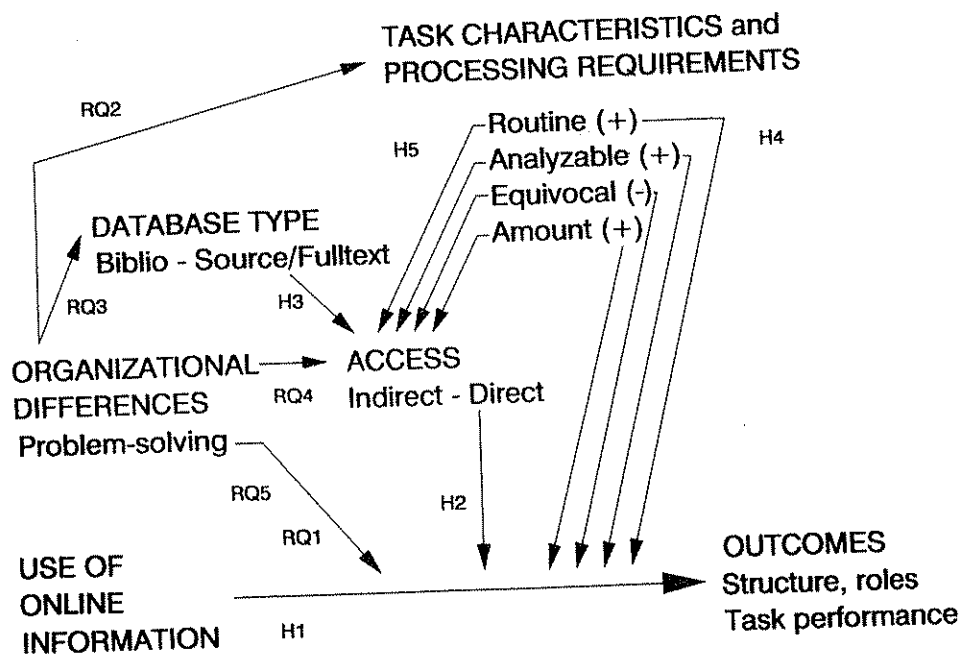


Fig. 1. Model of hypothesized relationships among use of online information, outcomes (perceived changes in performance, changes in roles and structure), access method, task characteristics and processing requirements, database type, and organizational differences.

*Access method.* One of the prime factors influencing evaluation and use of information is accessibility. Accessibility significantly influences both the level of use of an information system and a user's evaluation of the obtained information (Culnan 1984, 1985; Rice & Shook, 1988). One dimension of accessibility is the extent to which individuals obtain the information *indirectly* through search analysts who retrieve specific information requested by individuals, or *directly* as end users (Auster, 1985; Culnan, 1983a; Fenichel, 1980). These two forms of access represent the extremes of the extent to which the person who uses the information also performs the search, ranging from 0% (completely indirect) to 100% (completely direct). Search analysts are typically trained in the range of skills and knowledge necessary to conduct efficient and effective search strategies. They can provide value-added services such as negotiating search requests, suggesting appropriate search strategies and additional information resources, and interpreting search results. Strategy considerations include the breadth or specificity of information sought, the choice of suitable databases based on content and format of information, and tradeoffs between the cost of searching and the possible utility of the retrieved information (Meadow & Cochrane, 1981).

Individuals who obtain information from online external databases indirectly through search analysts are more distant from the context of the information sources and the retrieval processes. They are likely to be less familiar with the specific content and commands of various databases. They would thus not have had the opportunity to develop the familiarity required to retrieve information as successfully, inexpensively or conveniently. Because they are removed from the selection and interpretation of the online information, indirect users should be less likely to attribute causal relationships between the source of information and any improvements in performance. Further, it will be harder for the search analyst to understand the user's task context and know what constitutes effective results, so the information the search analyst provides to the end user may not contribute as highly to the user's work performance as would information retrieved directly by the end user.

#### HYPOTHESIS II (H2)

*Direct access to online information will be more strongly associated with perceived improvements in work performance than will indirect access.*

*Databases type.* One influence on access method may be the type of information needed—source data (numeric or full-text) or secondary data (bibliographic). Indirect users typically request bibliographic references to the information needed, rather than the source material itself (Fenichel, 1980; Wanger and Landau, 1980). Because full-text and numeric databases provide the final form as well as some of the context of the information, and thus can improve the user's ability to interpret the retrieved information, improving the likely benefit/cost ratio, users of full-text and numeric sources may be more likely to access such databases directly.

#### HYPOTHESIS III (H3)

*Individuals who use source (numeric and fulltext) rather than secondary (bibliographic) databases are more likely to access online database information directly.*

*Task characteristics and information processing requirements.* Tasks have been most parsimoniously characterized by two kinds of uncertainty: routineness and analyzability, originally described by Perrow (1967) (see also Comstock & Scott, 1977; Glisson, 1978; Grimes & Klein, 1973; Hage & Aiken, 1969; Overton, Schneck, & Hazlet, 1977; Van de Ven & Delbecq, 1974). Task *routineness* (often called variety) refers to the frequency of unexpected events that occurs in the process of task completion—it refers to the level of complex stimuli. Task *analyzability* refers to the degree to which individuals must spend time thinking about and creating or finding satisfactory solutions to problems—it refers to the level of uncertainty about cause-and-effect relationships.

Daft and Macintosh (1981) proposed that these two task characteristics generate two information processing requirements. *Amount* refers to the frequency or intensity of information needed to satisfy different levels of task routineness. *Equivocality* refers to the ambiguity of the meaning of information needed to satisfy different levels of task analyz-

ability. Equivocal information may reduce the amount of information needed, perhaps by providing richer and more valuable clues that cannot be obtained by simply processing more information.

Certain media match the information processing requirements of some tasks better than others. Because of the kind of information they can transmit (nonverbal cues, physical presence, qualitative information, etc.), some channels (face-to-face, videoconferencing, telephone) are particularly suited for tasks that are unanalyzable, non-routine, equivocal, and involve moderate amounts of information. Other, text-based organizational media (business letters, electronic mail, online databases) are theorized to be more appropriate for tasks that are analyzable, unequivocal, routine, and involve large amounts of information (Daft & Lengel, 1984; Rice, 1987; Rice & Case, 1983; Rice et al. 1991; Short, Williams, & Christie, 1976).

For example, Daft and Macintosh (1981) propose that for analyzable and routine tasks, successful information processing is likely to consist of moderate amounts of information with low equivocality, such as reports, rules and procedures, and statistical data. "Participants in highly analyzable settings may be able to rely more on quantitative forms of data, whereas qualitative data may be more appropriate in less analyzable situations" (Daft & Macintosh, 1981, p. 220). However, "to the extent that managers deal with problems that are unanalyzable, computer processing would not solve the information problem, because computers deal with unequivocal, standardized information" (p. 221). Finally, because users have access to large amounts of data through online services, users with tasks requiring the processing of more information are more likely to perceive improvements associated with use of online information in their work.

#### HYPOTHESIS IV (H4)

*Individuals who have tasks that (a) are more routine, (b) are more analyzable, (c) involve less equivocal information, or (d) involve greater amounts of information, are more likely to perceive improvements in work performance.*

*Task differences and access method.* Because the benefits of information are not easily determined in advance, individuals whose tasks are non-routine (Carlson, Grace, & Sutton, 1977; Culnan, 1983b) and unanalyzable, and whose tasks involve processing equivocal information, would be more likely to search for such information indirectly through search analysts. This is because the costs of learning the commands, interfaces, and formats of on or more online services and one or more databases is large relative to the user's certainty ahead of time about satisfying his or her information processing requirements. Further, the appropriate commands and analyses are likely to be different for each type of unanalyzable problem. Thus it would seem more beneficial to take advantage of the economies of skills developed by the search analyst. It also seems plausible that individuals with tasks that require small amounts of information would be less likely to search for information directly, again because they would find it difficult to justify their learning and searching costs over a few sets of information.

#### HYPOTHESIS V (H5)

*Individuals who have tasks that (a) are more routine, (b) are more analyzable, (c) involve less equivocal information, or (d) involve greater amounts of information, are more likely to access online information indirectly through search analysts.*

*Organizational differences.* Finally, there are surely other, organizationally based influences on access method, such as nature of the typical problems encountered in the organization, decisions about database vendors, etc. One unifying, general concept about organizational differences is their primary *problem-solving activity* (Kling & Gerson, 1978). Problem solving is the primary nature of the goals, objectives, and problems that organizations must attend to, and reflects the essential contextuality of information use in different organizations. The concept of problem-solving activity assumes that information is an important component and necessary resource ensuring organizational survival. Problem solving distinguishes general, rather than specific, types of organizations, yet provides a more detailed basis for differentiation than do other variables used in organizational ty-

pologies (e.g., mode of production (Woodward, 1965) or technology (Thompson, 1967)), according to Kling and Gerson. Thus, differentiation of organizations based on problem-solving activity provides a useful way of analyzing the effects of a technological application that changes the availability of information from external sources, such as commercial online databases.

ROGATORY QII (RQ2)

*Do database users in organizations with different problem-solving natures have different task characteristics and processing requirements?*

ROGATORY QIII (RQ3)

*Do database users in organizations with different problem-solving natures use different kinds (bibliographic vs source/numeric) of online databases?*

ROGATORY QIV (RQ4)

*Do database users in organizations with different problem-solving natures use different access methods, controlling for task characteristics, information processing requirements, and database type?*

ROGATORY QV (RQ5)

*Do organizational differences influence the relationship between usage and perceived improvements in work performance, controlling for task characteristics, information processing requirements, and access method?*

## METHOD

### *Sample*

Rather than a large-scale survey within a single organization, we studied four different organizations, based upon two primary criteria: variation in problem-solving activity, and regular use of external online databases. We chose this strategy because the common organizational research approach of studying a few organizations introduces the threat of low statistical power because of small sample size and reduced variability. Stratified random sampling from a large number of organizations to guarantee appropriate variability is ideal, but very difficult due to the resources required and the need to identify a sampling frame. Daft and Macintosh's (1981) study of relationships between task characteristics and information processing requirements used a strategy similar to ours: "to ensure that a wide range of tasks were included . . . rather than use variation within a single function . . . or a single organization, we included a variety of activities from several organizations . . . rather than randomly [selecting the organizations]" (Daft & Macintosh, 1981, p. 216).

First, we sought variation in the information demands placed upon the organization as indicated by its primary *problem-solving* purpose, discussed above. Second, we sought organizations where online databases were no longer a recent innovation or used infrequently, but rather were a *regularly used* source of external information.

Given these two primary criteria, we sought out representative organizations. One or more individuals in each of a large metropolitan newspaper, three separate divisions of a large aerospace company, a nonprofit research institute, a large bank, a small law firm, and a branch of a national investment brokerage house agreed to a number of interviews. These sites were used to develop concepts and inquiry strategies, pretest interview protocols and questionnaires, and identify appropriate organizations for the study. We then identified four other organizations that agreed to participate in the study. They included the R&D division of a different aerospace firm, a medical center, a moderately sized law firm, and the trading floor of a different large bank. The following sections first describe the samples and measures, and then the organizations.

### *Data sources and response rates*

*Qualitative data.* As in Culnan's study (1983a), initial open-ended interviews with library directors and search analysts of the aerospace research firm, medical center, and

law firm provided background on the nature of information requests, the amount and patterns of online database use, the choice of database vendors, and the role and impacts of online databases in the organization. At the bank, where online database use was not coordinated in a centralized location, relevant questions were addressed to individuals in various departments who had oversight of database use. In all organizations, structured interviews with individuals who either made information requests indirectly through search analysts, or who accessed the databases directly, also provided information on the implications of using online databases for their organizations. Overall, 48 individuals were interviewed as sources of qualitative insights (11 in the aerospace firm, 11 in the medical center, 8 in the law firm, and 18 in the bank).

*Quantitative data.* Quantitative data were collected by means of a self-administered questionnaire distributed to individuals who were *not* search analysts but who *did* use information retrieved from the databases in their work, *regardless* of the extent to which they accessed the databases directly or indirectly. The primary research design strategy was to survey all such respondents if reasonable; short of that, we attempted random sampling, or stratified random sampling in cases where tasks were explicitly different.

At the *medical center*, the library director and information search analyst distributed questionnaires to all individuals they identified as heavy users of external database information. At the *law firm* the information specialist in charge of online databases distributed questionnaires to all direct and indirect users, by reviewing billing statements of searches conducted over the six-month period previous to the study. Individuals were first categorized as heavy or moderate users. Then, because a sampling frame existed, a small sample was randomly selected from the two usage categories on this large list, and each respondent was requested to complete the questionnaire, with one follow-up request. At the *aerospace firm*, all individuals who requested online searches over the two months previous to the study (based upon billing documentation) were asked to fill out a questionnaire, again with one follow-up request. Finally, on the trading floor of the *bank*, the individuals interviewed were asked to distribute a questionnaire to at least two individuals at each of the eight blocks of trading desks specializing in a particular form of domestic security or type of foreign currency trading (thus representing a non-random but stratified sample).

Final response rates and sample sizes were 84% (19 respondents) at the medical center, 80% (24 respondents) at the law firm, 68% (26 respondents) at the aerospace research firm, and 75% (12 respondents) at the bank.

### Measures

This study used the following measures from the questionnaire:

1. *Task characteristics.* Standardized measures of *routineness* and *analyzability* were taken from a validation study by Withey, Daft, and Cooper (1983). The two scales were computed as the means of their constituent seven-point Likert-type items.
2. *Information processing requirements.* Standardized measures of *amount* and *equivocality* were taken from a study by Daft and Macintosh (1981). The two scales were computed as the means of their constituent five-point Likert-type items. Table 2 provides item and scale wordings and descriptive statistics for the constituent items of the task characteristics and information processing requirements scales.
3. *Use of database type.* "Estimate the percent of all the information received from online database searches that have been from the following types of databases." (bibliographic, numeric, and full-text databases were described, and the respondents were requested to check that the three percentages totaled 100%).
4. *Access method.* "\_\_\_ % of the time, I conduct the online search myself."
5. *Use of online information.* "Approximately what percent of the information you use in your job do you now get from online database searches?"
6. *Changes in work performance.* There are several standardized scales that measure dimensions of user satisfaction with information from systems (such as provided by Gallagher, 1974; Ives, Olson, & Baroudi, 1983; Regazzi, 1988; Zmud, 1978). However, they were not useful to our study because they focused on attributes of

Table 2. Item and scale wordings, descriptive statistics and reliabilities for task characteristics and information processing requirements scales

Variables and wording	Mean	S.D.
<b>Routineness<sup>a</sup> (Alpha = .76)</b>		
Are the tasks you perform the same from day to day?	3.56	1.58
Would you say your tasks are routine?	2.44	1.26
Do other individuals of your profession at (x firm) do the same job in the same way most of the time?	3.21	1.70
Do other individuals of your profession at (x firm) perform repetitive activities in doing their jobs?	3.41	1.65
Are your duties repetitious?	2.66	1.36
<b>Analyzability<sup>a</sup> (Alpha = .89)</b>		
Is there a clearly known way to do the major types of work you normally encounter?	3.03	1.65
Is there a clearly defined body of knowledge matter which guides you in doing your work?	4.01	1.74
Is there an understandable sequence of steps that can be followed in doing your work?	3.67	1.65
Can you actually rely on established procedures and practices?	3.62	1.60
Is there an understandable sequence of steps that can be followed in carrying out your work?	3.75	1.67
<b>Equivocality<sup>b</sup> (Alpha = .66)</b>		
I use information that can be interpreted in several ways and can lead to different but acceptable solutions.	3.65	1.09
There is typically more than one equally satisfactory solution for problems I face in my work.	3.74	.93
The information I use in making decisions could mean different things to different people.	3.80	.97
<b>Amount<sup>b</sup> (Alpha = .83)</b>		
In my work I typically keep gathering data until an excellent solution emerges.	3.68	.85
I typically wait until all relevant information is examined before deciding something.	3.53	.97
I typically go over all available information until an excellent solution appears.	3.48	.89
I typically acquire all possible information before making a final decision.	3.25	1.04

Source of scales and instructions for computing scale means: Daft and Macintosh (1981), and Withey, Daft, and Cooper (1983).

<sup>a</sup>Scale values: 1 = a small extent to 7 = a great extent.

<sup>b</sup>Scale values: 1 = almost never, 2 = seldom, 3 = sometimes, 4 = frequently, 5 = almost always.

information rather than outcomes, or were related to very specific outcomes such as relevance of the search result. We wanted a small set of items (a) of perceived change in work performance, that (b) were general, (c) incorporated a range of stages in performing tasks, (d) included a mix of efficiency and effectiveness, (e) had been used in prior studies of office information, and (f) would exhibit high scale dimensionality and reliability (see, for example, Hiltz & Johnson, 1989; Rice & Associates, 1984, pp. 211-213; Rice & Case, 1983; Rice & Shook, 1988). The items concerned (a) awareness of relevant information, (b) the time it takes to find information, (c) ability to make decisions, (d) my productivity, (e) quality of work, (f) quantity of work, and (g) confidence in work. Respondents were asked to indicate the extent to which each of these was significantly changed by the use of on-line information in their work (from 1 = significant decrease, to 5 = significant increase).

Two factors emerged from a varimax-iterated principal components analysis of the five-point Likert-type items: "effective," indicated by all the items except the second item (b) above, and "time," indicated by the second item. Factor scores for these two performance measures were created by the regression method. Increased effectiveness is indicated by *higher* "effective" scores; improvement in time spent finding information is indicated

by lower "time" scores. Table 3 lists item and scale wordings, descriptive statistics, factor loadings, and reliabilities for the change in work performance items.

Table 4 provides the descriptive statistics and reliabilities for the final variables and summary scales, along with means and difference tests in those measures across the four organizations.

### Descriptions of the organizations

The following descriptions provide, for each organization, (a) the problem-solving nature, (b) the level of use of online databases, (c) some of the kinds of improvements in performance associated with usage (RQ1), and (d) the general task characteristics and information processing requirements. However, they are not intended as case studies (e.g., Benbaset, Goldstein, & Mead, 1987; Carlson, Grace, & Sutton, 1977). Table 4 provides quantitative summaries of these and other measures for each organization.

*Medical organization.* Clinical departments use online databases to retrieve information primarily for treating patients and evaluating medical practices and support systems, and for some research. Medical research departments both produce and use online information to aid in detection and treatment of health problems, and to develop basic research on life processes.

The number of online searches conducted at the medical center increased by 207% from 1982 to 1985. In 1986, the search analyst located in the center's library conducted over 450 searches, all involving bibliographic databases.

Of the searches conducted for clinical purposes, roughly 80% pertained to patient treatment and 20% to patient diagnosis. Attending physicians use the information in treating diseases not typically encountered in practice and to ensure that methods used are based on current recommendations. Physicians also use the information during initial stages of research when information about a specific body of knowledge must be acquired to define a particular area of inquiry or to review research published on a topic over a specified period of time, especially if the articles are outside a physician's area of specialization, or written in foreign languages, information which would otherwise be difficult to obtain. For medical administrators, online databases provide convenient and feasible access to the published experiences of professionals in other medical institutions. Information retrieval from online databases has increased decision-making ability and confidence when reviewing and modifying hospital procedures and equipment, and selecting new drugs for use in the hospital.

Table 3. Item statistics and factor loadings measuring perceived changes in work performance associated with using online information

Perceived change in work performance	Mean	S.D.	Factors and loadings	
			Effective	Time
My ability to make decisions	3.87**	.74	<u>.82</u>	-.25
My productivity	3.97**	.83	<u>.89</u>	.11
The quality of my work	4.09**	.75	<u>.81</u>	-.07
Awareness of relevant information	3.99**	.75	<u>.73</u>	-.26
Confidence in my work	3.95**	.83	<u>.79</u>	-.13
Quantity of my work	3.61**	.85	<u>.71</u>	.30
The time it takes to find information	2.55**	1.38	.27	<u>.89</u>
Variance explained			55%	15%
Alpha reliability of underlined variables			.90	—

Item prompt: "Please circle the degree of change in these aspects of your work due to information from commercial online database searches . . . :"

Values for items: 1 = significantly decreased, 2 = decreased, 3 = no change, 4 = increased, 5 = significantly increased.

Principal components with varimax rotation was used to extract factors. Regression method was used to create factor scores.

\*\*Mean for each item is statistically significantly different from 3.00 (no change),  $p < .01$ , based upon two-tailed confidence intervals.

Table 4. Means of usage, task and performance variables, by organization and overall

Variables	Problem-solving orientation:	Organization				Overall	
		Medical	Law	Aerospace	Bank	Mean	S.D.
		Applying knowledge in clinical setting	Defending clients within legal code and precedent	Generating new knowledge for specific problems	Trading foreign currencies and domestic securities		
Database type:							
% Searches biblio		99.0	27.0	53.5	0.0	51.5*	43.0
% Searches fulltext		0.0	71.4	38.9	28.3	37.3*	38.8
% Searches numeric		0.0	1.3	7.2	71.7	11.4*	24.3
Access method:							
% Searches by self		0.0	71.8	9.6	99.0	39.0	43.0
Usage:							
% of work info obtained from databases		19.6	16.4	24.8	73.3	26.8*	26.3
Task scales:							
Routineness		3.1	2.7	2.7	4.3	3.0*	1.1
Analyzability		4.0	3.6	3.4	3.5	3.6*	1.4
Equivocality		3.3	4.1	3.6	4.0	3.7*	.8
Amount		3.8	3.7	3.1	3.3	3.5*	.7
Perceived changes in work performance:							
Effectiveness		-.29	-.12	.18	.36	0.0*	1.0
Time		-.29	.27	-.11	.26	0.0*	1.0
Sample size:		26	19	24	12		

\*Means among organizations differ significantly by Duncan multiple range test ( $p < .05$ ); ranges not shown.

Medical center respondents' tasks tend to involve more analyzable procedures and a substantial amount of information. Medical institutions in general employ standardized practices and procedures in providing medical service. Procedures are more routinized in clinics and hospitals than in some other kinds of organizations because of the importance associated with quality control in caring for other human beings, the vulnerability of an organization threatened with malpractice, and the need to transmit accurate and predictable information within and across subunit boundaries (e.g., doctors to technicians and pharmacists). Moreover, these practices and procedures involve a large number of information transactions.

*Legal organization.* Law firms engage individuals to defend and argue on behalf of their clients within the code and precedent of the legal framework. The timeliness of changes in the code and the importance of recent court decisions and arguments explains the usefulness of information retrieved from external legal databases.

At the law firm roughly 70% of the online searches involve two legal databases, representing 1550 hours of searching and retrieval during fiscal year 1985/86. Lawyers perform most of the searches; search analysts on the library staff or paralegal personnel conduct the rest.

The databases are used primarily for two reasons, as a tool for initiating research, and as a convenient means for "shepardizing," or the checking of citations and precedents after a document has been drafted, traditionally accomplished by using the printed version of *Shepard's Citations* (1985).

Legal firm respondents' tasks tend to involve a substantial amount of equivocal information. Legal personnel access online databases to obtain information used to defend a client's case, the outcome of which is uncertain and dependent on interpretations and applications of precedent. Arguments are generated not only on the basis of existing

precedent, but also on the ability of the lawyer to successfully match precedent with client needs. While standardization of legal procedures may account for the relatively high degree of task analyzability for law firm respondents, size and variety of caseload may account for the relatively low degree of task routineness.

*R&D division, aerospace research organization.* Online databases provide information that supports the production of new knowledge by enabling researchers to retrieve references to and abstracts of research (e.g., from the U.S. Census Bureau) and encyclopedic information (e.g., on the structure of various chemicals).

The number of online searches conducted by the research division of the aerospace firm increased by 154% between 1983 and 1986, with an average of roughly 300 searches per month in 1986, involving primarily bibliographic (54%) and fulltext (39%) databases.

Scientists and engineers use online databases during initial stages of research to obtain references to publications across a variety of fields, as well as during later stages of research when searching for an answer to a well-defined problem. Chemists use them to determine the structure of unknown compounds. Cost analysts use them to estimate the cost of proposed products. And individuals submitting grant proposals to government agencies use them to determine whether similar proposals have been previously funded. Online retrieval has also made it possible for scientists to test alternative hypotheses by locating published findings of other researchers conveniently and quickly. The results of a questionnaire distributed informally by library staff over a two-year period to individuals requesting information from online databases indicated that total estimated time saved was 4,737 hours, for an average of nearly a work week per person per search.

Respondents' tasks involve processing equivocal information. At least one explanation for this is that research entails charting new ground, developing areas that are initially undefined and uncertain. The research process, however, is based on scientific tradition and method and thus, at least to some extent, analyzable. The fact that even within the parameters of tradition and method, new problems must be addressed and new knowledge is acquired while conducting research, explains the relatively low degree of task routineness.

*Trading floor of a major bank.* Financial organizations such as banks and brokerage houses trade currency and securities of various kinds on an open market where prices change continuously or fast-breaking news affects prices.

Archival records of database usage were not available, but bank traders reported that they used primarily numeric databases (72%) and some fulltext news services (28%).

Two changes in the banking industry over recent years have resulted in the rapid growth of online financial databases. The first involves the replacement of the fixed (gold) standard by floating foreign currency exchange rates. Demand for currency now is based on the buyer's perception and assessment of the present and future state of the economy of the country the currency represents. The second involves the impact of deregulatory banking legislation passed by Congress since 1980 which expands the opportunity for banks to engage in trading domestic securities. Both international currency traders and domestic security traders obtain information on economic developments from online database news retrieval sources, as well as the latest bid and ask price of currencies and securities. For both types of traders, however, the databases do not simply provide access to more information more conveniently and quickly. Rather, databases are the required channel used to obtain information needed to trade; commercial online databases *define* the practice of modern trading.

The considerable routineness in traders' tasks is particularly interesting because traders are among those whose tasks also involve processing more equivocal information. The counter-intuitive tendency can be explained by the fact that decisions to trade currencies and securities are made rapidly and simultaneously by a number of individuals in a number of financial organizations. The rapidity of trading decisions requires standard mechanisms for buying and selling across organizations, but the information received from news sources, which affects the value of currencies and securities as well as the patterns and trends in price fluctuations, and the strategies of traders in other institutions that are only partially revealed in the database activity, represent considerable equivocality in the trading task.

## RESULTS

*Usage is the primary predictor of perceived changes in performance*

*Usage is associated with perceived changes in performance.* Table 3 shows that the mean score for each item measuring perceived change in work performance was statistically different from 3.0 (no change), indicating that respondents reported that perceived effectiveness increased, and time spent in finding information decreased, on average, supporting H1a.

Table 5 shows that greater use of the online information in one's work was slightly correlated with perceived improved effectiveness, providing support for H1b. Greater use of the information was positively, but not significantly, correlated with lower decreases in time spent in finding information than for less usage.

*Access is not associated with improvements in effectiveness, but are slightly associated with time spent.* Extent of direct access was not significantly correlated with the effectiveness factor, but was slightly correlated with decreases in time spent in finding information, providing mixed support for H2.

*Task contexts are not associated with changes in performance, but are slightly associated with access method.* None of the task characteristics or information processing requirements variables was significantly correlated with either of the two outcome factors, rejecting H4a, H4b, H4c and H4d. Further, level of direct access was associated only with greater task routineness, providing support for H5a, but rejecting H5b, H5c, and H5d. We must conclude that task characteristics and information processing requirements have no direct or indirect effect on the extent to which one feels using online information improves one's work. By implication, task contexts, at least those proposed by Daft and colleagues, do not reflect uncertainties about the extent to which online information is associated with changes in one's work performance.

*Task contexts and access method slightly affect the relationship between usage and perceived changes in performance.* However, another way to test the influence of tasks on the two outcome factors (H4) and on level of direct access (H5) is the extent to which they affect the relationships between usage of online information and perceived changes in work performance. To test this form of the hypotheses, the level of direct access and the four task variables were dichotomized at their median into high and low, and the bivariate correlations between usage of online information and the two work performance factors were computed within the high and low subsamples.

Table 6 shows that for higher levels of *direct access*, the correlation between use of on-

Table 5. Bivariate correlations of usage and task variables with access and outcomes

	% of searches by self	Outcome factors:	
		Effective	Time
Database type:			
% searches biblio	-.66***	-.17	-.37***
% searches fulltext	.42***	.06	.36**
% searches numeric	.53***	.21	.02
Access method:			
% of searches by self	—	.11	.24*
Usage:			
% of work info obtained from databases	.36***	.40***	.16
Task scales:			
Routineness	.24*	.19	.18
Analyzeability	-.06	-.06	.08
Equivocality	.37***	.15	.13
Amount	.09	.06	.00

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .005$ .  
 $n = 71-81$ .

Table 6. Correlations of percent of usage of online information in one's work, with performance factors, by median splits of access and task measures

Performance factors:	Access selfsearch		Task variables							
	High	Low	Routine		Analyzable		Equivocal		Amount	
			High	Low	High	Low	High	Low	High	Low
Effectiveness	.53**	.41**	.56**	.29	.47**	.39**	.40**	.40**	.40**	.46**
Time to find information	.16	.00	.21	-.05	.20	.14	.31	-.02	.41**	-.04 <sup>a</sup>
Sample sizes	34	40	36	37	34	40	30	44	35	39

\*\* $p < .01$ .<sup>a</sup>Only statistically significant difference in correlations between high and low condition, according to  $Z'$  test,  $p < .05$ .

line information in one's work and perceived increases in *effectiveness* are statistically significant, and nearly 33% higher (supporting H2, and reinforcing the bivariate correlation results, above). However, the correlations with decreased *time spent in finding information* are not significant.

For improvements in work *effectiveness*, the correlations are statistically significant, and nearly twice as high, for tasks that are more *routine* (supporting H4a, unlike the simple bivariate correlation results, above). Differences for the other task aspects were small (rejecting H4b, H4c and H4d). For decreases in *time spent in finding information*, the correlations are statistically significant and considerably higher only for tasks that involve greater *amounts* of information (opposite to H4d). (Remember that positive correlations indicate that *lower* use of online information is associated with *greater decreases* in time spent finding information than for *higher* use of such information, because even though the correlations are positive, implying that more use increases the time spent, the variable mean shows an overall *decrease* in time spent).

Due to the small sample sizes for each correlation,  $Z'$  tests (see Kleinbaum & Kupper, 1978, p. 107) of the differences between each pair of correlations involving the *effectiveness* factor show that none of the differences between correlations involving the *effectiveness* factor are statistically significant.  $Z'$  tests involving the *amount of time* factor show that only the difference in correlations for the high and low *amount* of information processing required is statistically significant.

However, *usage is the sole independent direct influence on perceived changes in performance*. Table 7 shows that when usage, access method, and organizational differences were considered jointly, only usage of online information in one's work was even moderately associated with perceived improvements in work effectiveness (supporting H1b), and unassociated with time spent in finding information. Thus, H2 (access), H4 (task contexts), and RQ5 (organizational differences) were all rejected by the multivariate analysis. One wider implication of these results is that the *outcomes* measured here, and the underlying relationships between use of information in one's work and such outcomes, seem generalizable across task contexts, access method, and organizations with different problem-solving needs. That is, as Table 4 showed, there were no significant differences across organizations in the outcome measures, in spite of large differences in database type and level of direct access.

#### Database type and organization influence access method

*Access method is strongly associated with database type*. Table 5 shows that more indirect access is associated with use of bibliographic databases, and more direct access is associated with use of numeric and full text databases (supporting H3). The proposed explanation is that direct users can justify the extra costs in searching by themselves because the nature of the database information (source data) allows them to expect that they can both find and interpret what they will search for. Conversely, the nature of bibliographic

Table 7. Regression of work performance factors on use, access method, and organizational differences

Independent variables	Dependent variables	
	Effective	Time
Use (H1)		
Percent of work information obtained from databases	.57***	.16
Access (H2)		
Percent of direct access	.00	-.14
Organization (RQ5)		
Medical	.24	.02
Legal	.35	.17
Aerospace	.45	.08
<i>F</i> (6,68)	3.8***	1.2
<i>R</i> <sup>2</sup>	.16	.01

Values are beta coefficients. Organizations were entered as dummy-coded values. Intercepts (mean of Financial organization) were not statistically significant.  
\*\*\**p* < .005.

databases (most of which provide explicit reference information, and/or abstracts) provide information that can be evaluated by search analysts independent of the needs of the end users of that information.

*Access method is associated with task routineness and equivocality.* Table 5 shows that greater task routineness (supporting H5a) and greater task equivocality (contrary to H5c) are both associated with greater direct access. Perhaps direct searchers can have good confidence that the costs involved in searching will be counter-balanced by the results because the users are familiar with what they are looking for and know they can identify its value. However, they need to reduce equivocality in information about those routine tasks, and this is best accomplished by direct access, which allows the user to search for, and make sense of, the online information in its database context. Task analyzability is not associated with access method (rejecting H5b), indicating that the extent of cause-effect relations in desired information is equally apparent whether the information is retrieved by the user or through a search analyst. The amount of information that must be processed in one's task is also not associated with method of access (rejecting H5d), indicating that comprehensive information may be obtained both directly by the end user and indirectly through search analysts.

*However, organizational differences are the sole independent direct influence on access method.* Table 8 shows that organizational differences other than task and database differences alone explain most ( $R^2 = 80\%$ ) of the variance in level of direct access (supporting RQ4, but rejecting H3 and H5).

## DISCUSSION

### *Summary of results*

The brief descriptions of the sites indicate that a variety of applications and changes in work performance were associated with the use of online commercial databases. Individuals in each of the four organizations managed the use of these databases in ways related to the problem-solving requirements of the organization, and used varying database contents and access methods (see Table 4).

The quantitative results showed that *method of access* was primarily influenced by database type, as predicted, but that these differences were superceded by organizational differences.

*Usage* was associated with perceived changes (mostly positive) in *work performance*. Multivariate analyses showed that these outcomes were not otherwise independently influ-

Table 8. Regression of access method on database type and organizational differences

Independent variables	Dependent variable access method (% of searches done by oneself)
Database type (H3):	
Bibliographic	-4.7
Full text	-4.2
Numeric	-2.1
Organization (RQ5):	
Medical	-.62**
Legal	.07
Aerospace	-.63**
<i>F</i> (6,66)	43.4***
<i>R</i> <sup>2</sup>	.78

Values are beta coefficients. Organizations were entered as dummy-coded 1,0 values. Intercept (mean of Financial organization) was not statistically significant.

\*\* $p < .01$ ; \*\*\* $p < .005$ .

enced by task characteristics, information processing requirements, access method, or organizational differences.

In general, *task contexts* (as measured by analyzability, routineness, amount and equivocality) *have almost no independent influence* on the process of accessing, using, and evaluating online external databases. That is, to the extent that information richness theory (Daft & Lengel, 1984) predicts that task context should affect the extent to which online information is appropriate for a task or is more easily and positively evaluated, it seems unsupported by the present results. However, information richness and the task concepts do provide heuristic value in understanding the kinds of tasks performed in these organizations, and the results of the correlational analyses for high and low levels of task contexts provide some insights into how task characteristics and information processing requirements can mediate the relation between usage and outcomes. Most of these results were in the directions predicted by the hypotheses.

Although the underlying concept of the difficulty in predicting the value of information in advance of spending time and energy in searching and retrieving it, and in evaluating it once retrieved, occurs throughout the information systems literature, and provides a useful heuristic framework, it does not serve as a strong explanatory basis for explaining perceived changes in work performance, through task contexts, access method, database type, or organizational differences. However, extent of direct access was well explained by database type, in accord with predictions, although differences in database type may simply be a result of organizational differences and choices.

#### *Potential problems in amount and interpretation*

While greater use of information from external online databases appears to be associated with perceived improved work effectiveness, there is some evidence that it may also increase the time spent finding information, for tasks that require processing a substantial amount of information (see Table 6). The availability of additional online content or sources of information may, for those who use online information for tasks requiring large amounts of information, leads to perceptions of *lesser* improvements in time required to process the information necessary than for those who use such systems less frequently (though still decreasing overall time spent in finding information).

The need to interpret increasing amounts of information now obtained through online retrieval may result in information overload and increased task demands and skill requirements. For example, at the aerospace research center, use of online databases has contributed to more variety and less analyzability in cost-analyzing grant proposals and production estimates in at least three ways: (a) by reducing the clerical components of obtaining

relevant information, (b) by increasing the number of research reports that have to be reviewed, which increased the researchers' awareness of the number of variables critical to the analysis of production costs, and (c) by increasing the likelihood of obtaining contradictory information from different sources, requiring further investigation and assessment.

Two solutions to these potential problems of overload and insufficient skill requirements are an expansion of the roles of certain individuals to interpret the information obtained, and an increase in the number of personnel to process the increased amount of information.

At the medical center, for example, respondents reported that their tasks involved processing a greater amount of information than did the respondents in other organizations, and that using the online information decreased their time spent searching for information more than it did in other organizations (though not significantly so). Interviews indicated that the search analyst at the medical center helped avoid burdening users with irrelevant information, and assisted in the interpretation of information obtained through the online searches in three ways: (a) by eliminating irrelevant entries from the search results, (b) by locating and reproducing hard copies of articles referenced, and (c) by, in some cases, even scanning the articles and highlighting the appropriate sections of the text that responded to the individual's query. These services aided the users but also considerably expanded the search analyst's role.

Bank respondents indicated that their tasks involved processing more equivocal information, relative to respondents in other organizations. Interviews indicated that the nature of the trading task requires individuals to focus on short-term changes in various markets. However, these decisions must be based upon positions taken over a period of hours, days, or weeks that are responsive to long-term changes or trends. Interpretations of past trends are important to trader managers who must determine overall positions that traders must take to conduct transactions that will result in profits over the long run. Indeed, section managers began each day by announcing the general "positions" that should guide the individual traders' decisions. To satisfy the demand for interpretation, an economist is located near the trading floor who uses full-text databases to help provide the context for developing the general position in three ways: (a) by responding to immediate fast-breaking news or sudden market shifts, (b) by responding to requests for specific data analysis, and (c) by producing a weekly report for traders on events likely to affect currency and securities markets. Thus the equivocality of information that must be processed in the short run (i.e., the latest bid and ask price provided by numeric databases) is to some extent reduced by the economist's interpretation of the broader context derived from the full-text news databases.

Such descriptive results indicate that future research on use online external databases should attempt to (a) measure the extent of information overload, (b) consider these and other internal organizational buffering strategies in greater detail, and (c) identify additional examples of how the adoption of online external databases contributes to changing the nature of tasks and roles performed by both the search analysts and the individuals who use the information.

#### *Issues of access method*

The results concerning access method differ from and expand upon Culnan's (1983a) finding that individuals who access databases directly have more complex tasks. Here, direct access was associated with greater task routineness and equivocality, but not with task analyzability or amount. Perhaps Culnan's measures reflected only ambiguity of information processed, rather than variety in the task (as Daft & Macintosh, 1981, suggested may be the case in other studies of organizational information processing).

The interviews indicated that *direct* users have tasks that require them to do at least one of the following: (a) access databases on a regular basis (such as bank traders who made ongoing decisions based upon online numeric and some fulltext data), (b) download and manipulate the information (such as researchers who analyze source information statistically), or (c) perform a series of contiguous steps, each of which requires the analytic skills of the searcher to know how to execute subsequent steps (such as lawyers who track

judicial precedents). Thus it appears that because of certain task characteristics and the need to use certain system processing capabilities, indirect access is the time-consuming iterative process that bypasses many of the advantages of online information while also increasing the possibility of misunderstandings and insufficient interpretation between end users and search analysts. However, if one's task is not sufficiently routine or equivocal, the variability in value of information retrieved may make it difficult to justify the costs of learning the commands and databases anew for each search, in order to do direct searching.

Research on access to information sources and systems has shown that if the new sources or systems are not highly accessible, conventional alternatives will be used even when they provide slower response and lower quality information (Culnan, 1984, 1985; O'Reilly, 1982; Rice & Shook, 1988). The technological capacity of online systems to provide specific as well as comprehensive information from enormous databases suggests that conventional alternatives (here, using a search analyst as an information source) may be less effective and perhaps more costly in the context of certain kinds of task characteristics and information processing requirements, yet may still be preferred because of concerns about the medium, access methods, or value of the retrieved information. That is, when one's tasks are non-routine, it seems individuals prefer to have others pay some of the costs of access and uncertainty of evaluation of the retrieved information—especially those whose job it is to learn those skills. However, if the task involves equivocal information, then one may be more likely to access the information directly, in order to understand the full context of the information at the time of retrieval. Thus organizations implementing online external databases should pay particular attention to questions of access method, and ensure a good understanding between search analysts and users of the nature of tasks performed by the end users. As we have seen, two ways to do this are to expand the search analysts' role, and increase the number of search staff.

Future research as well as practice could focus on the importance of access to online databases relative to other information sources, and on organizational policies, rewards, and norms that influence choice of access method.

### CONCLUSION

Quantitative and qualitative analyses indicated that users of information from online commercial databases associate moderate benefits with use of that information in their work. However, while the expanding information economy increases information processing requirements for organizations, and the convergence of computers and telecommunications offers opportunities for improved performance and strategic advantage, the potential of online databases will be better realized when their relationships to organizational problem-solving requirements, database types, task characteristics, information processing requirements, and access methods are better understood and managed.

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