ORGANIZATION SCIENCE
Vol. 3, No. 4, November 1992
Printed in U.S.A.

TASK ANALYZABILITY, USE OF NEW MEDIA, AND EFFECTIVENESS: A MULTI-SITE EXPLORATION OF MEDIA RICHNESS*

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The present study explores the central tenet of media richness theory, derived from contingency theory: when (1) information processing capabilities match (2) information processing demands, (3) performance will improve. This article tests whether using communication media that differ (1) in media richness or social presence (2) in conditions of differing task analyzability (3) affects self-reported performance components such as quality of work, effectiveness, productivity, ability to obtain information, decision-making ability, access to others, etc.

The article first reviews the theoretical constructs of media richness and social presence, task characteristics, and performance, with particular reference to organizational computer-mediated communication media. It also identifies important but untested assumptions that media richness theory has, to date, made about the forms of the relationships among these variables. The theory assumes that use-performance relationships are *nonmonotonic*, that is, that the relationship between use and outcomes is positive when a medium's richness "fits" task requirements, and negative when it does not. The theory also assumes that use-performance relationships are *symmetric*, that is, that the relationship between use and outcomes in different task conditions is similar but opposite for "rich media" and "lean media."

Hypotheses test the direction and form of relationships involving use of online databases in several pooled organizations, electronic mail in one organization, voice mail in two organizations, and videoconferencing in one organization, in task conditions varying in analyzability.

Results are mixed, depending on analytical method and dataset used, but show modest support for the contingent effect of task condition on the relationship between use of these new media and performance components. Results are stronger for information-lean media than for information-rich media. The results are generally monotonic and asymmetric, thus qualifying prior media richness assumptions.

Implications for theory and research include slight support but conceptual qualification of media richness theory, and an improved understanding of new organizational media. Implications for management and practice include a need to appreciate appropriate uses of and opportunities for different communication media in organizational contexts.
(MEDIA RICHNESS; NEW MEDIA; CONTINGENCY THEORY; ORGANIZATIONAL COMMUNICATION)

Organizational Information Processing and Media Richness

The continuing development and increasingly widespread adoption of new organizational media have prompted questions about the role and effectiveness of both traditional (face-to-face, telephone, memos) and new (online databases, electronic mail, voice mail and videoconferencing) organizational communication channels (Rice and Associates 1984). The present research attempts to clarify the conceptual aspects of, and to test for empirical evidence for, relationships between the use of new media and effectiveness in different task environments.

*Accepted by Robert Zmud; received December 5, 1988. This paper has been with the author for four revisions.

1047-7039/92/0304/0475/$01.25

Contingency theory argues that organizations must respond to new and changing environmental conditions, by redesigning their internal processing capabilities through structures and technologies (Galbraith 1977; Lawrence and Lorsch 1969; Tushman and Nadler 1978). A basic underlying principle is the "law of requisite variety": the variety of the conversion process must match the variety of the input demands (Ashby 1968). Thus contingency theory makes at least one very explicit proposition: performance is not assured by any particular organizational design, but is contingent on an appropriate match between contextual variables (such as task demands) and organizational arrangements (such as communication structures and media).

This general model has been extended to relationships between task characteristics, choice and use of organizational media, and performance. The best known formulation has been referred to as the managerial information processing model, or information/media richness theory (Daft and Lengel 1984, 1986; Trevino, Lengel and Daft 1987). That is, performance depends to some extent on the match between the characteristics of the medium used and the characteristics of the task. However, as Daft and colleagues argue, use of any communication channel involves both costs as well as information exchange capacities. Group meetings, for example, can be used to provide and exchange information for a wide range of tasks. But the costs of using such a channel (difficulties in scheduling everyone to be in the same place at the same time, or in interpreting and negotiating meanings among the members) may in the end be greater than the benefits of communicating through that channel to accomplish that task.

These medium-task interactions have cumulative and aggregate effects, both for the individual and for the organization. Thus, to the extent that an organization does not provide both the appropriate structures and the appropriate media for the kinds of task environments its members face, individuals are less likely to communicate effectively or to perform well, and the organization is less likely to respond successfully to environmental demands, to perform well, and to survive. The following sections describe the primary constructs of this model: media characteristics (social presence and richness), task characteristics (analyzability), and performance.

Media Characteristics

Communication media differ in the extent to which they can (1) overcome various communication constraints of time, location, permanence, distribution and distance, and (2) transmit the social and nonverbal cues of human communication (Steinfield 1986a; Short, Williams, and Christie 1976; Rice 1987; Rice and Associates 1984). In a similar vein, Trevino, Lengel, and Daft (1987) suggest that channels differ in the extent to which they (1) overcome situational constraints, (2) convey ambiguous information, and (3) provide symbolic cues. Researchers have developed two related concepts for discussing these differences in media characteristics: social presence and media richness.

Social presence is the degree to which a medium is perceived as conveying the actual physical presence of the communicating participants (Short et al. 1976). This social presence depends not only upon the words conveyed during communication, but also upon a range of nonverbal cues including facial expression, direction of gaze, posture, attire, and physical distance and many verbal cues (timing, pauses, accentuations, tonal inflections, etc.) (Argyle 1969; Birdwhistle 1970). Social presence is most frequently measured either by a set of semantic differentials measuring "personalness," "warmth," etc. of the medium, or by measures of the appropriateness of different media for a range of common organizational communication tasks. Johansen (1977) and Reid (1977) review a wide range of studies invoking the construct of social presence.

Numerous studies have found that text-based computer-mediated communication systems are perceived as less appropriate for social, intuitive or emotional tasks that are difficult to analyze (such as negotiating) and more appropriate for less socio-emotional tasks that are more easily analyzed (such as exchanging information) (Hiltz and Turoff 1978; Rice 1984; Rice and Case 1983). Other studies have also found that electronic mail reduces communication cues (Sproull and Kiesler 1986), though some studies have found considerable levels of socio-emotional content in computer-mediated content (Rice and Love 1987). Rice, Hughes, and Love (1989) found that respondents who rated electronic mail as less appropriate for tasks requiring high social presence, and as more appropriate for tasks not requiring high social presence, reported more positive outcomes associated with their use of electronic mail.

Based upon the work of Bodensteiner (1970), Daft and Lengel (1984, 1986) and Trevino, Lengel and Daft (1987) developed the concept of *information richness* or *media richness*. The authors propose that communication channels differ in the extent to which they are able to bridge different frames of reference, make issues less ambiguous, or provide opportunities for learning in a given time interval (Daft and Lengel 1986, p. 560). Proposed determinants of media richness include the medium's capacity for immediate feedback, the number of cues and senses involved, personalization, and language variety. To the extent that a task requires rich communication content, different media are likely to be more or less effective in conveying that content.

There are as yet only a few published empirical tests of the media/task/performance proposition, from a media richness perspective. Ochsman and Chapanis conducted tests of media arrayed along "a continuum of [10] communication modes from a rich face-to-face mode to an impoverished typewriting mode" (1974, p. 618). Greater use of richer media was highly correlated with shorter problem solution time, with more messages sent and with more messages received; however, the effects were almost completely explained by the difference between oral and nonoral media. Holland, Stead, and Leibrock (1976) found weak correlations ($r = 0.34$) between uncertainty in important technical information and the use of communication channels explicitly proposed as having greater media richness, but did not assess performance. Lind and Zmud (1991) found that use of information rich channels contributed to convergence between information systems personnel and noninformation systems personnel on the importance of the firm's business activities, and the importance of information technology to support those activities. Further, this convergence was then associated with innovativeness in information technology. Using 355 hypothetical communication incidents categorized into 18 common workplace situations, Trevino, Lengel, and Daft (1987) found that face-to-face communication was ranked by 100 managers as more likely to be chosen (46%) for communication tasks involving ambiguity than telephone, written and electronic mail (all around 25%), while electronic mail was more likely to be chosen (62%) for tasks involving situational constraints than the other media (telephone 51%, written 43% and face-to-face 17%). Markus (1988) used these same 18 situations, but allowed her sample of nearly 500 managers to rank each medium for each situation. She found a similar correspondence between empirical rankings of media and theoretically expected rankings.

Table 1 summarizes the few extant empirical rankings of media along explicit social presence or media richness scales.

Task Characteristics

Central to media richness theory is the proposition that tasks vary with respect to certain characteristics. In turn, different media, as discussed above, vary in the extent to which they can convey the kinds of information needed for these different task characteristics.

TABLE 1
Empirical Rankings of Various Communication Media Along Information Richness and Social Presence Scales

Communication Medium	Study						
	A	B	C	D	E	F	G
Face-to-face	1.00	4.4	4.4	0.81	4.6	—	100.0
Video	—	—	—	0.24	—	—	—
Telephone	0.94	3.8	3.8	−0.52	4.3	4.5	85.9
Voice conferencing	0.79	—	—	−0.18	—	—	—
Group meeting	0.65	—	—	—	4.1	—	—
Voice messaging	0.63	—	—	—	3.7	3.5	—
Group gathering	0.59	—	—	—	—	—	—
Chart/graphs	0.50	—	—	—	—	—	—
Computer report	0.47	2.5	1.1	—	—	—	—
Document/report	0.27	3.3	3.2	—	—	—	48.2
Memos	—	3.6	3.5	—	—	—	54.0
Electronic mail	0.13	3.5	2.8	—	—	—	75.3
Facsimile	0.11	—	—	—	—	—	—
Handwritten note	0.11	—	—	—	—	—	64.4
Letter/message	0.00	—	—	−0.85	3.5	3.7	67.1

A: Zmud, Lind, and Young (1990). Criteria: 14 items representing accessibility, information quality, cue variety, and feedback, for lateral communication. Values are dimensional scaling scores, normalized to 0.0–1.0 scale. Scale: seven-point MDS comparisons derived from the two MDS dimensions (quality and feedback) for lateral communication projected onto a plane bisecting the space defined by the two dimensions. $n = 158$.

B: Schmitz and Fulk (1990). Criteria: mean of 4 items measuring timely feedback, nonverbal cues, tailored messages, and rich/varied language. Scale: 1 = not at all rich to 5 = extremely rich. $n = 491$.

C: Fulk and Ryu (1990). Same criteria as for B. $n = 58$.

D: Short, Williams, and Christie (1976, p. 71). Criteria: semantic differential items such as warmth, personalness.

E: From present 2nd voice mail data. Criteria: mean of perceived appropriateness of using the various media for 10 communication activities: exchanging information, bargaining and negotiating, getting to know someone, asking questions, staying in touch, exchanging time-sensitive information, generating ideas, resolving disagreements, making decisions, and exchanging confidential information (see Rice and Love 1987, for a review of the use of appropriateness scales and these communication activities). Text was memos/letters. Voice mail score from average or above users, to guarantee experience with the new medium. Original scale: from 1 = appropriate to 5 = inappropriate. Scale reversed to make direction of ranking comparable to the other studies. $n = 159$, except 102 for VM users.

F: From present 1st voice mail data. Criteria and scale: same as for E. $n = 240$, except 150 for VM users.

G: Trevino, Lengel, Bodensteiner, Gerloff and Muir (1990). Respondents' rating of media, 1–100, based upon overall assessment of medium's capacity for timely feedback, nonverbal cues, tailored messages, and rich/varied language. $n = 40$.

Perrow (1967) originally proposed and described task *analyzability* as one of the two basic task characteristics, along with routineness. Task analyzability refers to the way that individuals are able to respond to problems that arise in the process of task completion. Analyzable tasks are those for which predetermined responses to potential problems, and well-known procedures, are available and useful, because outcomes are well understood.

When activities are analyzable, there are more information cues available, more procedures established, and individuals do not have to turn to past or shared experiences for information about how to accomplish the task. In analyzable task environments, events and processes are "hard, measurable and determinant" (Daft and Weick 1984, p. 287). Analyzable tasks involve more rules and procedures, thus involving the processing of more formalized and written information.

In unanalyzable task environments, processing is "more personal, less linear, more *ad hoc* and improvisational" (Daft and Weick 1984, p. 287). "When activities are not

analyzable... information may tend to be general and equivocal because precise coding schemes would not be congruous with the work activities" (Daft and Macintosh 1981, p. 212). Unanalyzable tasks require individuals to think about, create, or find satisfactory solutions to problems outside of the domain of facts, rules, or procedures. Individuals working in unanalyzable task environments cannot rely on more information, procedures, or predictability of the outcome to guide their actions. Simon (1965) argues that nonprogrammed decisions are solved on the basis of judgement, intuition, creativity, rules of thumb, and socialization of employees. Information about these kinds of decisions cannot easily be communicated by text or numbers; interpreting this information depends upon interpersonal interaction and social cues. "Instead, personal means of coordination, which involve on-the-spot sharing of information among personnel, are an effective way of dealing with unanalyzable problems" (Kim 1988, p. 475). The low predictability of the task will make it difficult to identify the kinds of information needed and the utility of that information for the task (Daft and Macintosh 1981). Thus related cues available in richer media, such as another person's credibility, expertise, or status, could be used to assess the likelihood of resolving the task requirements through that communication source. Thus, for unanalyzable tasks, people are more likely to use information rich media (e.g., face-to-face communication) because there is a greater chance of accomplishing the task for a given search effort, and because feedback is quicker (Blandin and Brown 1977; Randolph and Finch 1977; Tushman 1978; Van de Ven, Delbecq and Koenig 1976; Zmud, Lind and Young 1990).

Simply put, information-lean media should match the requirements of analyzable tasks, and information-rich media should match the requirements of unanalyzable tasks, thereby leading to improved performance. Using information-lean media for unanalyzable tasks would not satisfy the task demands (social and symbolic cues, feedback, interpretability); using information-rich media for analyzable tasks would involve unnecessary costs (socializing, interpretation, and situational constraints).

Daft and Macintosh (1981) provide a more extensive model of the relationship between task characteristics and media capabilities. They propose that the two task characteristics, analyzability and variety, generate two types of information requirements: equivocality and amount. Thus unanalyzable tasks lead to the need to process equivocal information, which requires media that can convey multiple cues, the joint construction of meaning, and rapid feedback (Withey, Daft, and Cooper 1983). That is, theoretically, equivocality is an intervening variable mediating the extent to which different media match the task characteristic of analyzability. However, Daft and Macintosh (1981) show that analyzability is significantly correlated with equivocality (regardless of the level of variety).

Because analyzability is a casually prior task variable, has been applied in considerable prior research, and seems to have the most frequent and persistent implications for the task/media match, the present study differentiates task environments on the basis of analyzability. Further, Daft and Macintosh (1981) showed that task variety is uncorrelated with equivocality, controlling for analyzability. For these reasons, and in the interests of space and parsimony, this study considers only the task characteristic of analyzability, not variety, and does not use measures of equivocality.

Performance

Performance is the dependent variable of the information processing model, but it is often under-conceptualized, under-operationalized, and over-determined. Media richness theory proposes that communication effectiveness is what is affected first by the match of media and task characteristics. Yet, the proximate and intermediate activities and processes linking usage and performance are typically *assumed* rather

than identified and tested. As King and Kraemer (1984, p. 472) argue concerning the relationship of computing in general to performance, "Very general goals of the organization might be agreed on (e.g., making a profit, organizational survival, sustained growth), but the linkage between use of computing and the achievement of these broad goals requires specification of much more detailed subgoals directed specifically at the application of the technology to particular tasks and needs." Thus, as argued in greater detail by Rice and Bair (1984), more global aspects of unit and organizational performance that are presumed to be influenced by the use of new media must, and can, first be explained by specific forms of more proximate communication and work benefits directly related to capabilities of those new media.

The considerable prior literature on organizational uses and effects of new media provide substantial evidence for the kinds and extent of such benefits (as well as disadvantages). Because computer-based media such as online databases, electronic mail and voice mail represent the convergence of the capabilities of computer processing *and* the connectivity of telecommunications networks, they may directly affect performance components involving communication (see Rice 1980, 1987; Rice and Bair 1984; Steinfield 1986b).

Markus (1984, pp. 56–60) generally sums up these potential impacts as influencing spatial and temporal factors (such as allowing individuals in different places or working at different times to coordinate their work) and communication channels and networks (such as allowing more diverse individuals to communicate or to alter access to individuals and information). Rice and Bair (1984, pp. 212–213) summarize a wide variety of studies that show associations of use of new office media with reductions in the use of more constrained media, reductions in errors and delays in transmission, improvements in work quantity and quality, increased awareness and diversity of relevant information and colleagues, improvements in one's ability to distribute and obtain information, etc. Hiltz (1988), Hiltz and Johnson (1989) found that the first dimension (explaining 61% of the variance) of two "productivity impact" factors in a large-scale study of four computer-mediated communication systems included "increased quantity of work," "increased quality of work," "useful for your work," and "easier to reach people." The second factor was related to career advances and improved stock of information and ideas. Steinfield (1986a) noted that the most likely effects of a sophisticated electronic mail system, as reported by 220 users, included "access to higher quality information," "improved productivity," and "improved connectedness [to others]." Further, Markus (1984, pp. 61–64), Porter and Millar (1985), and Rice (1987), among others, discuss how new media can be used to improve (inter)organizational performance, by allowing organizations to process communication and information between competitors, vendors, and customers.

Thus, we argue that (1) there are intermediate performance components that may contribute to, or detract from, overall individual and organizational performance, (2) there is no single, standardized measure that can be used to assess the effects of these media on performance, but (3) there is a reasonably well-established, explicitly operationalized, generalizable and consistent set of measures based upon the considerable literature to date, which may be conceptualized as communication-based effectiveness components of performance.

Empirical Foundations of Media Richness Theory: An Example

An initial test of one aspect of media richness theory by Daft, Lengel, and Trevino (1987) (see also Lengel and Daft, 1988) provides the primary empirical support for the theory so far. Briefly, they found that a sample of 15 managers in one organization who reported that they would choose media that were better matched to the

media richness requirements of 60 workplace incidents (as rated by a separate set of judges) had higher performance ratings, than did another sample of 15 managers who would make less well-matched choices. The present study extends and clarifies several aspects of this initial test of media richness theory.

First, the original study used rigorously developed and explicit, but nonetheless hypothetical, incidents as occasions for respondents to indicate their intended media choices. The present study uses measures of the *extent* to which different media are used in day-to-day work settings instead of a binary measure of hypothesized choice. Second, the present study extends the theory to consider usage of several new organizational media. Third, the present study involves moderately-sized samples from several organizations.

Fourth, the present study uses components of performance that are more proximate to the influence of media use, rather than assessments of global performance across all aspects of employment (as discussed above). Further, the present study provides explicit operationalizations of these components. The Daft, Trevino and Lengel study used a single, four-point item provided from organizational personnel records for 30 of the 95 managers who rated the media. Presumably the performance measure was a subjective judgement from each of the managers' superiors applied equally by all supervisors across these managers. Apparently the organization studied would not make the criteria for this judgement available, preventing any assessments of the replicability, reliability, or validity of the measure.

Fifth, the present study uses the full, continuous range of combinations among usage, task characteristics and performance components available in the samples. The 30 respondents in the Daft, Trevino and Lengel study comprised the top 15 and bottom 15 "media aware" (on the basis of correlations between the individual's media choices and the equivocality of the various incidents) managers from an initial sample of 95 (Lengel and Daft 1988, p. 229). The researchers requested the performance measure when the correlations between equivocality of the incident (as rated by independent judges) and richness of the medium (chosen by 95 managers) indicated that some managers were more "media aware" than others.

Hypotheses

The prior discussions lead to the general hypothesis of media richness theory, that:

Performance effectiveness (here, intermediate performance components) is related to the extent to which communication channel usage (here, several new media) matches task characteristics (here, analyzability).

Schoonhoven (1981) argues that several often untested assumptions are embedded in much organizational information processing research. The first is most often made explicit: that contingency relations are interactions, and not simple main effects. This assumption is reflected in the general hypothesis just provided.

However, two other assumptions are generally implicit and untested: *nonmonotonicity* and *symmetry*. In the context of testing the implications of varying media richness, *nonmonotonicity* is the assumption that the level of the relationship (such as a correlation) changes direction (from negative to positive) along the range of media-task matches (from poor match to good match). *Symmetry* is the assumption that relationships for opposite types of media (information-lean media versus information-rich media) are similar but operate in the opposite direction. That is, for analyzable tasks, performance should *increase* with usage of information *lean* media but should *decrease* with usage of information *rich* media. Information richness theory and results so far (Daft and Lengel 1984; Daft, Lengel and Trevino 1987;

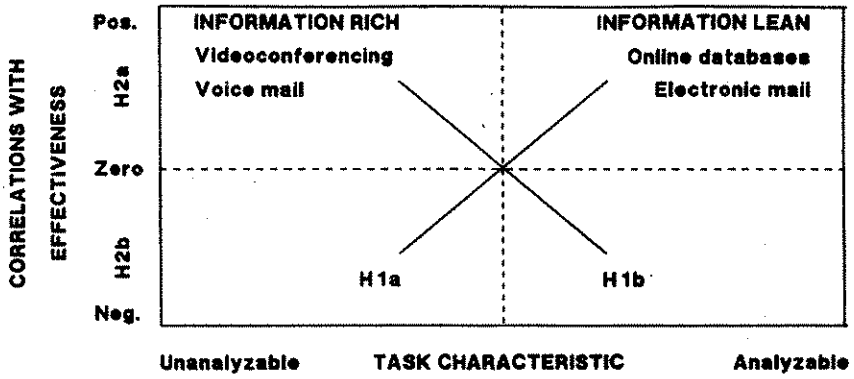

FIGURE 1. Hypothesized Correlations of Media Use with Effectiveness, by Level of Task Analyzability.

Lengel and Daft 1988) explicitly propose or implicitly assume that the relationship between media and performance across task environments is *both* nonmonotonic and symmetric. However, nearly all the effect in the Daft, Lengel and Trevino study comes from the 15 *media-aware* respondents: 87% of these were high performers and 13% were low performers, while the percentages for the 15 media-unaware managers were 47% and 53%, respectively. These results imply that the relationship is *not* symmetric, and it may be *nonmonotonic* only for the high-awareness condition.

Thus, two separate subhypotheses are necessary to test for symmetry:

*H*1a. *Use of information-lean media will be more strongly associated with positive performance effectiveness in analyzable task environments than in unanalyzable task environments.*

*H*1b. *Use of information-rich media will be more strongly associated with positive performance effectiveness in unanalyzable task environments than in analyzable task environments.*

And two separate subhypotheses are necessary to test for nonmonotonicity:

*H*2a. *Performance effectiveness is positively related to media use when medium usage is matched to task characteristics.*

*H*2b. *Performance effectiveness is negatively related to media use when medium usage is not matched to task characteristics.*

Figure 1 portrays these hypotheses in the symmetric (H1a and H1b) and nonmonotonic (H2a and H2b) form implied by Daft and Lengel (1984, 1986).

Huber (1984) and Rice and Associates (1984), among others, argue that new media can provide opportunities for modern organizations to cope with their increasingly complex and information-intensive environments. However, Daft, Lengel and Trevino (1987) argue that new media cannot provide the cues, feedback, and interpretation necessary for many organizational situations, especially those involving upper-level managers. Thus the present study tests the hypotheses in the context of four new organizational media—online databases, electronic mail, voice mail, and videoconferencing. Figure 1 locates each of these media within the hypotheses.

These four media vary in theoretically relevant aspects of media richness (see also Table 1). Online databases are relatively information lean because they transmit textual and often numeric information, and provide no interactivity with other individuals, though they do provide considerable interactivity with the information

through search and retrieval capabilities. Electronic mail is relatively information lean because it is text-based, though it can provide feedback (asynchronous, though often rapid) and more semantic cues. Voice mail is relatively information rich because it provides oral communication (as noted above, Ochsman and Chapanis 1974 concludes this to be *the* distinguishing difference between lean and rich media) as well as feedback (asynchronous, though often rapid). Videoconferencing is relatively information rich because it provides voice as well as visual cues in addition to synchronous feedback.

Methodology

Five research projects investigating the adoption, application, and impacts of these four computer-mediated organizational information and communication systems provide the data for the present study. Sources for more detailed information about the sites are studies of online databases (Hart and Rice 1991), electronic mail (Rice and Contractor 1990; Rice, Grant, Schmitz, and Torobin 1990; Rice and Shook 1990a), voice mail (Rice and Shook 1990b; Rice and Steinfield 1992), and videoconferencing (Svenning and Ruchinskas 1984). The present study uses only measures of media use, task analyzability, and intermediate components of performance from each of these studies. Thus, the present study is essentially a set of replicated quantitative case analyses. However, both because different measures of usage and effectiveness are appropriate for studying these different media, and because each sample is part of a different research study, the measures are not strictly comparable across the samples (see discussion section).

Use of Online Databases

In four organizations, data were collected by a self-administered questionnaire distributed to individuals, other than search analysts or librarians, who used information retrieved from external commercial computer databases in their work. At a medical center, individuals identified by our organizational contacts as heavy users of information obtained from online databases received questionnaires. At a law firm those who retrieved information directly from the online databases as well as those who requested information from search analysts were randomly selected to receive the questionnaire. At an aerospace firm, all individuals who requested online searches over the two months previous to the study received the questionnaire. Finally, on the trading floor of a bank, at least one individual at each block of trading desks specializing in a particular form of domestic security or type of foreign currency trading received a questionnaire. Final response rates 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, for a total of 81. Because of the small sample sizes, the four subsamples were pooled.[1]

[1]It may be argued that only those users who conducted searches by themselves could be good judges of the effectiveness of online database usage. Alternatively, because the online information results were provided by intermediaries, and formatted in ways that clearly identified the source and nature of the information, it could be argued that anyone who used the information in their work, whether via direct search or via an intermediary, is an appropriate subject. Results were analyzed for both the larger set of subjects who were direct users and who used intermediaries, and the smaller subset of direct users. T-tests showed no statistically significant differences between the subsamples with respect to task analyzability or the effectiveness factor score. Regression and correlation results for direct searchers only are generally similar to those of both direct and indirect searchers, except they are less likely to be statistically significant because of the smaller sample size. The correlations for unanalyzable and analyzable task environments provided directional support similar to that of the full sample, and the z-test was similarly not significant.

It may also be argued that pooling the four organizations using online databases blurs possible effects of organizational differences. ANOVA's showed no statistically significant differences in either analyzability

TABLE 2
Descriptive Statistics and Factor Loadings for Online Information Data

Variables	Mean	S.D.	Factors
Performance Components (a)			Effective
Work confidence	3.95	0.83	0.83
Work productivity	3.97	0.83	0.78
Decision-making ability	3.87	0.74	0.76
Work quality	4.09	0.75	0.62
Percent variance explained			56%
Eigenvalues			2.25
Percent of work information obtained from databases	35.7	41.7	
Analyzability scale	3.6	1.4	

a = Scale values from 1 = significantly decreased to 5 = significantly increased. Principal components analysis was used to extract factor. Regression method was used to create the factor scores. $n = 81$.

Media usage was measured as the reported percentage of information used in one's work that was obtained from online databases. Only respondents who indicated that they used at least some online information in their work were included in the analyses. *Task analyzability* was computed as the mean of the four items assessed and standardized by Withey, Daft, and Cooper (1983): "Is there a clearly known way to do the major types of work you normally encounter?," "Is there a clearly defined body of knowledge matter which guides you in doing your work?," "Is there an understandable sequence of steps that can be followed in doing your work?," and "To do your work, do you actually rely on established procedures and practices?" (Alpha reliability for this and the other analyzability scales from each dataset was above 0.80.) Examples of tasks included searching abstracts for use in diagnosing an unfamiliar disease, tracing the development of legal precedents, scanning scientific literature for related developments in materials design, or searching news wires for economic information to use in understanding currency exchange fluctuations. However, in each site the range of uses was quite diverse. The *performance component* measure consisted of the four items loading on a single principal component. Table 2 provides item wordings and values, descriptive statistics and factor loadings of these items.

Use of Electronic Mail

The electronic mail data come from a small, decentralized federal agency office in charge of providing services and supplies to other agencies. The 86 employees were all civil servants; most were white collar professionals, although some were clerical workers. A questionnaire was administered to all employees before, and nine months after, implementation of a local area network linking personal computers and providing electronic mail services. The sample consists of the 67 of 86 (78% response rate) who returned their questionnaires at T2.

Usage of electronic mail was measured by the reported percent of the day spent using that medium. Only respondents whose usage was greater than zero were

(highest for the medical center, lowest for the aerospace firm) or the effectiveness factor score (highest for the bank trading room, lowest for the medical center) across the organizations. There were differences, however, among the organizations on other measures, such as direct or indirect access, and uses of different types of databases, but these are incidental to the variables studied here.

Thus, for both questions, the evidence seems to justify pooling subjects and organizations.

TABLE 3
Descriptive Statistics and Factor Loadings for Electronic Mail Data

Variables	Mean	S.D.	Factor
Performance Components (a)			Effective
Quality of work	4.32	0.79	0.77
# of contacts initiated	3.67	0.79	0.77
Quantity of work	3.79	1.15	0.66
Percent variance explained			53%
Eigenvalues			1.60
Electronic mail usage (% of day)	7.66	11.94	
Analyzability scale (b)	4.62	1.28	
Standard operating procedures	4.43	1.78	
Well-defined subject matter	3.89	1.53	
Tasks with clearly defined outcomes	4.65	1.77	
Rules, policies and regulations	5.14	1.54	

a = Scale values from 1 = significantly decreased to 5 = significantly increased. Principal components analysis was used to extract factor. Regression method was used to create the factor scores.
b = Scale values from 1 = not at all to 7 = very much.
n = 49–65.

included in the analyses. *Task analyzability* was computed as the mean of four items that were similar, but not identical, to the Withey, Daft and Cooper (1983) measures, which we obtained after this particular study had begun. Examples of tasks conducted via electronic mail included sending electronic memos about updated governmental procedures, or coordinating responses to clients' complaints. The *performance component* measure consisted of the factor score of three items loading on a single principal component. Table 3 provides item wordings and values, descriptive statistics and factor loadings of these items.

Use of Voice Mail, 1

A large insurance organization in the process of pilot testing a voice mail system provided the setting for the first voice mail (VM) data. Data collection included a questionnaire survey five months after implementation of the VM system, and computer-monitored VM usage data collected weekly.[2] The population included 458 employees; 243 responded (a response rate of 53%).

Questionnaire measures of *usage* included self-reported total of voice messages sent and received per business day. Computer-monitored VM *usage* measures of the number of voice messages sent and the number received (based on 6,400 data points) were divided by the number of weeks (mean 12.5, minimum 2, maximum 21) since the respondent first used the system, and then normalized (using Proc Rank with the Blom formula in SAS) to enable use of parametric statistics.[3]

The questionnaire included the standard measure of *task analyzability* (Withey, Daft, and Cooper 1983). Examples of tasks for which voice mail was used included responding to a request about the names of participants in upcoming meetings, delegating responsibilities for handling a critical client insurance claim, and rapidly assembling a multi-department proposal for a newly announced investment opportunity. The *performance component* measure consisted of the factor score of six items

[2]This dataset comes from a longitudinal study of voice mail implementation. The sample size for the over-time analysis using the same variables was too small to report here, and involved different measures, so we chose to use only the items comparable to the cross-sectional analysis of the voice mail 2 data set.

[3]See Rice (1990), Rice and Borgman (1983), and Williams, Rice and Rogers (1988, Chapter 6) for a discussion of the extensiveness, reliability and validity of computer-monitored data.

TABLE 4
Descriptive Statistics for First Voice Mail Data

Variables	Mean	S.D.	Factor
Performance Components (a)			
I have more time to get information	2.74	1.60	0.75
I waste less time in telephone tag	2.41	1.64	0.78
I have shorter phone calls	3.61	1.65	0.73
I get more information about what a caller wants with voice messaging than with a message slip	2.12	1.46	0.78
I get more work done because I am able to manage my time better	3.13	1.70	0.84
When I travel I use time more efficiently	3.03	1.65	0.75
Percent variance explained			60%
Eigenvalue			3.58
Media usage (per business day) (b)			
Computer-monitored voice messages sent	1.88	2.53	
Computer-monitored voice messages received	1.79	1.88	
Self-reported voice messages sent and received	7.16	5.63	
Analyzability scale	2.56	0.85	

a = Scale values from 1 = strongly agree to 7 = strongly disagree. Principal components analysis was used to extract factor. Regression method was used to create the factor scores. Factor scores reversed to match direction of performance components (increased effectiveness) across analyses.

b = Usage measures reported here are nonnormalized; the analyses use the normalized form of these measures. The discrepancy between the sum of voice messages sent and received (1.88 + 1.79 = 3.67) and the self-reported messages sent and received (7.16) should be qualified in two ways. First, self-reported messages "sent and received" is likely to include voice answering messages received, which is a separate computer-monitored variable. Second, computer-monitored variables were divided by the number of weeks since the account was first set up (then multiplied by 5 to convert the values into business days). For those people who took several weeks before sending their first message, the mean value would obviously be biased downward. Taking both these factors into account, the total computer-monitored usage per business day is 4.91. Dropping those individuals who only used the system once raises this mean even higher. Still, some discrepancy exists between computer-monitored and self-reported system measures (see Note 2).

n = 122 for questionnaire items; 294 for computer-monitored (users only).

loading on a single principal component. Table 4 provides item wordings and values, descriptive statistics and factor loadings of these items.

Use of Voice Mail, 2

The U.S. branches of an international chemical company that had been using voice mail for approximately three years provided the site for the second voice mail data. Questionnaires were sent to 255 voice mail users sampled randomly within two strata: east or west coast (50% each) and level of usage (light—9 or less messages sent and received in one month; moderate—between 10 and 49; and heavy—over 50); 165 responded (a 65% response rate).

Voice mail *usage* was measured by a question asking for the number of voice messages sent and received in an average week. Computer-monitored *usage* measured the total number of voice messages sent and received, taken from the monthly system usage report used in selecting the respondents (see Note 3). Both measures were normalized as in the voice mail 1 study. The questionnaire included the standard multi-item measure of *task analyzability*. Examples of tasks for which voice mail was used included a branch manager's request for clarification of points in a headquarters report, and employees checking their voicemail "in-box" for important matters while on vacation. The *performance component* measure consisted of the

TABLE 5
Descriptive Statistics for Second Voice Mail Data

Variables	Mean	S.D.	Factor
Performance Components (a)			Effective
I have more time to get information	2.66	1.51	0.78
I waste less time in telephone tag	2.23	1.69	0.87
I have shorter phone calls	2.89	1.74	0.83
I get more information about what a caller wants with voice messaging than with a message slip	2.46	1.63	0.84
I get more work done because I am able to manage my time better	2.74	1.66	0.85
When I travel I use time more efficiently	2.19	1.45	0.82
Percent variance explained			70%
Eigenvalue			4.20
Media usage (sent & received) (b)			
Reported average per week	25.22	24.34	
Computer-monitored, for month	57.48	60.59	
Analyzability scale	3.22	0.83	

a = Scale values from 1 = strongly agree to 7 = strongly disagree. Principal components analysis was used to extract factor. Regression method was used to create the factor scores. Factor scores reversed to match direction of performance components (increased effectiveness) across analyses.

b = Usage measures reported here are nonnormalized; the analyses use the normalized form of these measures.

$n = 159$.

factor score of the same six items used in the voice mail 1 study. Table 5 provides item wordings and values, descriptive statistics and factor loadings of these items.

Use of Videoconferencing

The videoconferencing sample comes from 10 semiautonomous divisions of a large U.S. organization involved in oil and gas development, chemicals, transportation, mining, manufacturing, and petroleum products and services. The organization was in the process of implementing a national, full-motion videoconferencing system. The respondents came from a stratified, proportionally-weighted random sample of 1086 exempt personnel from 15 locations, 35 job types and 9 organizational levels, representing 18% of the workforce. Data collection included a questionnaire administered approximately three years after implementation of the videoconferencing system in a few of the divisions. Although 848 individuals responded (a response rate of 79%), we analyze data only from the 196 respondents who had used the videoconferencing system at least once by the time of the survey.

Videoconferencing *usage* was measured by a question asking for the number of times the respondent had participated in a videoconference at the organization. The questionnaire included only one item from the measures of *task analyzability* used in the electronic mail study—the "tasks with clearly defined outcomes" item.[4] Video-

[4]As with the voice mail 1 sample (see note 2), this dataset comes from a longitudinal study of videoconferencing, both involving a stratified random sample of approximately 900 employees, measured before and after the implementation of videoconferencing. Because of concerns about questionnaire length, and requests for additional items, only the "clearly defined outcomes" item was kept on the T2 questionnaire. So the analysis could have used the full 4-item analyzability scale from T1. However, only 22 people existed in both datasets, answered all the items, and had used videoconferencing at least once. We chose to use the larger sample and the single item at T2 rather than the extremely small sample and the task analyzability scale from T1.

TABLE 6
Descriptive Statistics for Videoconferencing Data

Variables	Mean	S.D.	Factors
Performance Components (a)			Effective
My efficiency	3.34	0.51	0.87
My productivity	3.41	0.53	0.87
My effectiveness	3.29	0.48	0.83
Percent variance explained			74%
Eigenvalue			2.21
			Access
Access to necessary information	3.05	0.68	0.86
Access to right people at right time	3.28	0.79	0.86
Percent variance explained			74%
Eigenvalue			1.47
Videoconferencing usage (levels) (b)	1.84	0.97	
Analyzability item (c)			
Tasks with clearly defined outcomes	4.29	1.56	

a = Scale values from 1 = a large decrease to 5 = a large increase. Two principal components analyses with varimax rotation were used to extract a single factor from each of the two sets of performance components. Regression method was used to create the factor scores.

b = "I have used the videoconferencing system:" 0, 1, 2–3, 4–7, 8–12, 12+ times (but only users included in the present analyses).

c = from 1 = not at all to 7 = very much. See note 5.

n = 164–196.

conferencing was used for tasks such as discussions of national marketing plans, operational processes between divisions, within-division decisions among geographically dispersed managers, and increased visibility of the CEO among the geographically separate personnel. Two *performance component* measures consisted of the factor scores resulting from five items loading on each of two principal components—effectiveness and accessibility. Table 6 provides item wordings and values, descriptive statistics and factor loadings of these items.

Procedures

Multiple Regressions with Interaction Term. Schoonhoven (1981) suggests that an appropriate way to test for the general contingency hypothesis is an interactive model of fit. This consists of regressing the performance measure on (1) the media usage measure, (2) task analyzability, and (3) an interaction term consisting of usage multiplied by analyzability. The direction and significance of the interaction term may be used to test the general hypothesis of an interaction. Schoonhoven (1981) entered the interaction term first and the independent main effect variables following, which biases the partitioning of variance in favor of the hypothesized effects. Entering the variables hierarchically ensures the theoretical requirement that the effects of use and task analyzability are removed before any possible interaction effects are identified. Also, the use of interaction terms often creates multicollinearity between the interaction term and one of its constituent variables, resulting in unstable coefficients and suppression of statistical significance of the subsequent term entered into the regression equation (Blalock 1979). Because the interaction term is entered last, its statistical significance will be reduced by any multicollinearity, providing a conservative test. For reasons, then, both of theoretical consistency and of the threat of multicollinearity, the main effects should be controlled for first. Regardless of the

order of entry, Schoonhoven points out that the regression approach masks nonmonotonic relationships.

We use the term, *directional support*, when the beta coefficient of the interaction term is in the hypothesized direction, but not statistically significant. For measurements used in these studies, the direction (slope) of the beta coefficient for the interaction term for information lean media should be positive (that is, higher media use times greater task analyzability should be positively correlated with increased performance). Similarly, the direction for the interaction term for information rich media should be negative (that is, higher media use times greater task analyzability should be negatively correlated with increased performance). We use the term, *statistical support*, when the beta coefficient of the interaction term is statistically significant, in the hypothesized direction.

Correlations Stratified by Task Analyzability. One straightforward way to test for the media-task interaction for information lean and rich media (H1a and H1b, respectively), and identify possible nonmonotonicity (H2a and H2b) is to correlate usage and performance components within groups stratified into "analyzable" and "unanalyzable" task environments. The results can be tested to identify the direction and significance of each of the two correlations, and the extent of difference between the two correlations. The difference between the two correlations (of media use and performance component) is assessed by a t-test on the difference in the Fisher's z-transformations of the correlations (Klienbaum and Kupper 1978, p. 107).

Directional support for the general media-task interaction hypothesis (H1a or H1b) occurs when one correlation is statistically significant in the proposed direction and the other is not, or when neither correlation is statistically significant but the difference is significant and in the proposed direction. When one or both of the correlations are statistically significant, *and* the difference is statistically significant in the hypothesized direction, the result provides *statistical* support for H1a or H1b.

Directional support for the hypothesis of nonmonotonicity (H2a and H2b) occurs when the correlations have the proposed opposite signs (positive or negative), and one of the correlations is statistically significant, or the difference is statistically significant. *Statistical* support occurs when the correlations have the proposed opposite signs, and one or both of the correlations is statistically significant and the difference is significant.

Symmetry can be subjectively assessed by the degree to which the results provide opposing results for information-lean (H1a), and for information-rich (H1b), media.

Slope Test

However, Schoonhoven does provide a more complex and infrequently used method for estimating the extent to which the association is nonmonotonic over the range of task characteristics (1981, Appendix, pp. 376–377). Briefly, it consists of dividing the unstandardized *B*-coefficient of the usage measure by the unstandardized *B*-coefficient of the interaction term, and multiplying the result by -1. This "slope test" identifies the value of task analyzability at which the correlation between usage and performance changes from positive to negative. If the value occurs within the empirical range of the analyzability measure, then the relationship may be nonmonotonic (assuming that the interaction term itself is significant). If the value occurs outside the range, then the relationship is monotonic.

Results

The regression results in Table 7, the correlation results in Table 8, and the slope test results in Table 9, assess the hypotheses as portrayed in Figure 1.

TABLE 7
Results from Multiple Regressions with Task × Analyzability Interaction Term

Performance Measures	Usage Measure	*B* and Beta Coefficients: Use	Analyze	Interaction	Adj R^2	d.f. and *F*-ratio
		INFORMATION LEAN MEDIA:				
Online Database:						
Increased effective	% of work info	−0.00	−0.11	0.01*	0.19	3, 70 = 6.6**
		(−0.09)	(−0.15)	(0.59)		
Electronic Mail:						
Increased effective	% of day using	−0.06	−0.83**	0.02	0.42	3, 23 = 6.6**
		(−0.71)	(−0.92)	(1.26)		
		INFORMATION RICH MEDIA:				
Voice Mail 1:						
Increased effective	rep sent + rec	0.00	−0.25**	0.01**	0.09	3, 115 = 4.8**
		(0.08)	(−0.24)	(0.30)		
	mon sent	0.03	−0.14	0.03	0.00	3, 115 = 1.2
		(0.02)	(−0.14)	(0.07)		
	mon rec	0.23	−0.13	−0.07	0.00	3, 115 = 1.0
		(0.21)	(−0.12)	(−0.18)		
Voice Mail 2:						
Increased effective	rep sent + rec	1.16***	0.16	−0.27***	0.27	3, 133 = 17.5***
		(1.43)	(0.16)	(−1.05)		
	mon sent + rec	0.85**	0.17*	−0.18*	0.14	3, 133 = 8.6***
		(0.96)	(0.18)	(−0.67)		
Videoconferencing:						
Increased effective	# videoconf.	0.22	−0.02	0.02	0.08	3, 149 = 5.6***
		(0.22)^	(−0.03)	(0.11)		
Increased access	# videoconf.	0.23	0.06	−0.01	0.02	3, 149 = 1.9
		(0.25)	(0.10)	(−0.07)		

* = $p < 0.05$.
** = $p < 0.01$.
*** = $p < 0.001$.
Coefficients without parentheses are unstandardized *B*-coefficients; values in parentheses are standardized partial coefficients.

Online Database

The interaction term in the regression was positive and statistically significant. For analyzable task environments, the correlation of usage of online database information with increased effectiveness (decision-making ability, and work productivity, quality and confidence) was positive and statistically significant. For unanalyzable task environments, the correlation was also positive, but not statistically significant. The difference in correlations was not statistically significant. The slope test also indicates a monotonic relationship. These results provide directional support for H1a, and statistical support for H2a, but reject H2b and thus the assumption of nonmonotonicity.

Electronic Mail

The interaction term in the regression was positive but not statistically significant, providing only directional support for the general relationship (H1a). For unanalyzable task environments, the correlation of usage of electronic mail with increased communication effectiveness (quality and quantity of work, and initiation of communication contacts) was essentially zero, while for analyzable task environments it was positive and statistically significant. The difference in correlations was statistically significant, supporting both H1a and H2a. The slope test showed that the correlations

TABLE 8

Correlations of Media Usage with Effectiveness, by Task Analyzability (High) or Unanalyzability (Low)

Performance Components	Measure of Usage	Analyzability		Absolute Z-Diff.	Type of Support
		High	Low		
	INFORMATION LEAN MEDIA:				
Online Database (a)					
Increased effectiveness	% of work info	0.56***	0.30	1.32	directional
Electronic Mail (b)					
Increased effectiveness	% of day using	0.67*	0.01	1.97*	statistical
	INFORMATION RICH MEDIA:				
Voice Mail 1 (c)					
Increased effectiveness	reported sent + rec	0.07	0.24*	1.08	directional
	monitored sent	0.10	0.16	0.34	none
	monitored rec	0.28**	0.24*	0.27	none
Voice Mail 2 (d)					
Increased effectiveness	reported sent + rec	0.25*	0.52***	1.83*	statistical
	monitored sent + rec	0.37***	0.38***	0.07	none
Videoconferencing (e)					
Increased effectiveness	# video meetings	0.34***	0.30**	0.27	none
Increased access	# video meetings	0.07	0.37**	1.90*	statistical

* = $p < 0.05$.
** = $p < 0.01$.
*** = $p < 0.001$.
n for each correlation; $a = 40$; $b = 22$–29; $c = 48$–85; $d = 62$–85; $e = 61$–95. c, d = Score values reversed to maintain similar directionality of measures (increased effectiveness) across analyses.

TABLE 9

Slope Tests: Range of Task Analyzability Values, and Value of Analyzability at Which Correlation of Media Usage with Performance Component Changes Sign

Performance Components	Measure of Usage	Range of Analyzability	When Correlation between Usage and Effectiveness Changes Sign
	INFORMATION LEAN MEDIA:		
Online Database (a)			
Increased effectiveness	% of work info	1.0–6.4	0.64
Electronic Mail (b)			
Increased effectiveness	% of day using	2.2–6.6	2.98
	INFORMATION RICH MEDIA:		
Voice Mail 1 (c)			
Increased effectiveness	reported sent + rec	1.0–4.8	−1.29
	monitored sent	1.0–4.8	3.28
	monitored rec	1.0–4.8	3.26
Voice Mail 2 (d)			
Increased effectiveness	reported sent + rec	1.25–5.0	4.24
	monitored sent + rec	1.25–5.0	4.74
Videoconferencing (e)			
Increased effectiveness	# video meetings	1.0–7.0	−9.87
Increased access	# video meetings	1.0–7.0	16.97

changed from positive to negative at 2.98, just within the lower range of analyzability (2.2–6.6). However, as the interaction term is not significant, this result does not support the assumption of nonmonotonicity (H2a and H2b). Thus the correlation analysis and slope test reject the assumption of nonmonotonicity.

Voice Mail 1

In these regressions, none of the interaction terms was statistically significant in the proposed negative direction, thus rejecting the general hypothesis of a media-task interaction for information rich media (H1b). However, H1b and H2a received directional support from the correlation involving reported messages sent and received in unanalyzable task environments, but not by the correlations involving monitored number of messages sent, and monitored number of messages received. However, for all three measures of usage in analyzable task environments, the correlations with the performance components (such as overcoming situational constraints and better management of work time) were positive (and one significant), rejecting H2b and thus the assumption of nonmonotonicity. The slope tests provided no support for a nonmonotonic relationship involving the reported measure of usage. The change in correlation direction occurred within the upper range of analyzability values for both of the monitored usage measures, indicating nonmonotonicity; however, because the interaction term was not significant this does not seem persuasive.

Voice Mail 2

In these regressions, interaction terms for both monitored and reported total messages sent and received were negative and significant, providing statistical support for the general hypothesis of a media-task interaction (H1b). In the correlation analyses, the self-reported number of messages sent and received was significantly correlated with increased effectiveness (such as overcoming situational constraints and better management of work time) in both task environments. The difference between the correlations was statistically significant in the hypothesized direction (more positive for unanalyzable tasks), providing statistical support for H1b and H2a but rejecting H2b and thus nonmonotonicity. The monitored number of messages sent and received was significantly and positively correlated with increased effectiveness, at equal values in both task analyzability environments, also providing support for H2a but not H2b, thus rejecting the assumption of nonmonotonicity. The slope test indicated that, in spite of the high positive correlations, the relationship of both measures of usage with the effectiveness factor became negative at the very upper range of the analyzability scale, providing support for H2b (because the interaction terms were significant). That is, when tasks are extremely analyzable, higher usage of voice mail may well indeed be associated with decreases in effectiveness (here measured as better use of the telephone in ways that improve work outcomes).

Videoconferencing

In these regressions, neither interaction term was statistically significant, rejecting the general hypothesis of a media-task interaction for information rich media (H1b). The correlations between use and work effectiveness (efficiency, effectiveness, and productivity) for both analyzable and unanalyzable task environments were both positive and statistically significant, providing support for H2a but rejecting H2b and thus the assumption of nonmonotonicity. The use of videoconferencing in unanalyzable task environments was significantly and positively correlated with increased access (to necessary information and people), while the correlation in analyzable task environments was essentially zero, providing support for H1b and H2a, but rejecting H2b. The slope tests also rejected the assumption of nonmonotonicity.

Discussion

The results provide mixed support for the general hypothesis that task analyzability influences the relationship between media usage and performance components. The summaries provided above and Table 8 show that of the nine high-low correlation pairs tested, four received no support (neither or both correlations were statistically significant, but the difference was not), two received directional support (one of the correlations was statistically significant, in the predicted direction), and three received statistical support (at least one correlation was statistically significant, in the predicted order, and the difference was statistically significant).

However, as discussed below, neither assumptions of symmetry nor nonmonotonicity were supported by the results. Symmetry assumes that the relationships for information-rich media are the exact opposite for those of information-lean media. Nonmonotonicity assumes that the level of the relationship changes direction along the range of media-task matches.

Symmetry

The regression interaction terms for the two information-lean media (databases and electronic mail) were positive (one significantly, one directionally), providing support for H1a. For the interaction terms involving information-rich media, two of the seven terms were negative and significant, and two of the other terms were negative but not significant. However, two other terms were positive but not significant, and one was positive and significant. Overall, these results provide mixed support for H2b. In the correlation analyses, one of the two correlation pairs for both information-lean media was higher for analyzable task environments. For information-rich media, four of the seven correlations did not provide even directional support, while one provided directional and two provided statistical support. Overall, it is difficult to assert that the interaction effect of task analyzability on the medium-performance relationship is symmetric. The association of use of information-lean media with performance components seems more affected by task analyzability than does the use of information-rich media.

Nonmonotonicity

None of the correlational analyses supports the assumption of nonmonotonicity (H2a and H2b). Overall, the slope test and interaction analyses supported the assumption of nonmonotonicity only for two of the nine analyses (voice mail 2). Even these placed the sign change at the extreme end of the analyzability range. The results indicate that the relationships are generally *monotonic*, in the sense that the correlation of media use with various performance components is generally positive in both analyzable *and* unanalyzable task environments.

However, when media *are* matched to task requirements, the association between usage of new media and performance components can become even stronger. That is, in general the correlations in Table 8 are highest for the analyzable tasks involving usage of information-lean media (online databases and electronic mail), and the unanalyzable tasks involving usage of information-rich media (voice mail 2 and videoconferencing).

Limitations

Each of these datasets is relatively small, including approximately 20 to 200 individuals, depending on the analysis and the number of missing cases. These small sample sizes reduce the likely statistical significance of the findings. Further, although in each study either a census or a systematic sampling was attempted, the incomplete

response rates cannot guarantee that the respondents accurately reflect the organization's population. Finally, the measures of usage and performance components generally differ across the samples. Certainly future research should investigate a wider range, and more consistent measures, of both proximate and global performance components.

With four media, five study datasets and a handful of organizational sites, we cannot control for likely organizational differences. Thus organizational and measurement differences are confounded with media differences. Indeed, a possible critique of the results is that all differences or relationships are really artifacts of underlying contextual and cultural differences among the organizations, over and above the tested relationships among task, media use, and performance. Different organizations, even different work units, may develop and maintain different norms for information sharing and media use. Under such a scenario, it is possible that greater performance is associated with using the "right" channels (which may differ for initiating versus responding), and with communicating about the "right" topics. For example, it may be that in the government agency, using electronic mail for handling ambiguous, multi-level bureaucratic matters is associated with lower effectiveness not because of any inherent task unanalyzability, but because the norms of government and military organizations discourage bypassing layers of authority. Such alternative explanations are most salient when comparing the results for the two voice mail studies, where, though the results are similar in direction, the correlations are positive and significant for all relationships in the 2nd organization. It is possible that because the 1st organization provides more direct service to individual customers, effectiveness can at most be supported through mediated communication, whereas the 2nd organization may use voice mail more to support more administrative and technical communications across wide geographical areas. Additional studies will be necessary to understand whether what appears in these results to be effects of matches between media and tasks may instead be matches between organizational contexts and effectiveness.

However, we feel that the present study does represent an advance over the few small-sample, single-organization empirical tests of media richness theory so far. Further, to the extent that results are similar across different measures, regardless of organizational differences, (such as for online databases and electronic mail), the overall implications are stronger.

Another area for future improvement would be to measure task characteristics, task information processing requirements, media use and proximate and global performance for each communication event as it occurs. To the extent that all such incidents in a decision process could be identified and reliably measured, using the average task environment is more general but incorporates measurement error, thus providing a conservative test of the model. Saunders and Jones (1989) suggest some ways (such as simulations and activity logging) in which incidents involving actual media use might be measured. However, to the extent that all such incidents cannot be easily identified or reliably measured, and cannot be clearly linked to specific proximate and global outcomes, the standard scale of task analyzability used here provides a practical, theoretically derived, and operationally explicit way to assess task characteristics averaged over an individual's work activities.

All measures used here, except for computer-monitored voice mail use, are self-reports, with the attendant threats of poor recall and unreliable measurement. The use of ratio-level measures of media use in actual work conditions does, however, seem an improvement over a binary measure of media choice in responding to hypothetical incidents. Further, the various measures of outcomes for each of the present media were designed to reflect conceptually meaningful proximate perfor-

mance components for that medium. These more proximate components of performance may well be more theoretically as well as practically justified than global measures of worker performance, especially in the absence of explicitly operationalized and validated global measures in prior research.

Still, rigorous tests of the primary proposition of media richness theory—that performance will increase when media characteristics match task characteristics, and will decrease when they do not—await studies with enough organization-media combinations and consistent measures to discriminate among potential alternative explanations.

Because of the cross-sectional nature of these analyses, alternate causal paths may be imagined. That is, are task environments themselves changed by the use of various media? Could the widespread availability of electronic mail within an organization increase the analyzability of the users' general task environment? If that were the case, then the task/media "match" would be improved, but the variance in analyzability might be reduced. Both would raise questions about the results of a cross-sectional analysis.

While the present analysis tested a proposition of media richness theory in the context of specific new organizational media, and Daft et al. (1987) tested other propositions in the context of traditional media, a full test would include a complete range of media actually used. The weak results found here may be due to the restricted range of media involved and thus a restricted range of variance and relationships. For example, Daft et al.'s strongest results occur when they compare the maximally different communication channels of face-to-face and business memos; here, the assumption of symmetric results is best supported by the two extremes of media richness used here (online databases and videoconferencing).

Implications, and Directions for Future Research

The present analyses, like the Daft et al. (1987) analysis, have ignored all other potentially relevant variables in the interests of parsimony and clarity. However, here and elsewhere we argue that media usage is contextual. A wide range of symbolic and situational influences on both media use and media evaluations exist. These include directionality of communication, norms for information use, social influences on media evaluations, formality or status of the medium in particular organizations, the user's level in the organizational hierarchy, accessibility, public/private nature of the organization, different stages in the decision-making process or the organization's life cycle, etc. (Daft and Lengel 1986; Daft, Lengel, and Trevino 1987; Dobos and Jeffres, 1988; Dykman 1986; DiSalvo and Larsen 1987; Feldman and March 1981; Fulk, Steinfield, Schmitz and Power 1987; Markus 1988; Rice 1980, 1987; Rice and Associates 1984; Rice, Grant, Schmitz and Torobin 1990; Rice, Hughes, and Love 1989; Rice and Shook 1988, 1990a; Saunders and Jones 1989; Trevino, Lengel and Daft 1987; Volard and Davies 1982). In addition, although there is some consistency in rankings of media according to social presence and media richness, both social presence and media richness are perceptions dependent upon intrinsic characteristics of the medium, as well as upon particular communication contexts and the individuals' experiences, attitudes and preferences.

Theorizing about social information processing, task interdependence, the relational nature of communication, organizational structure, and problems with individual error variance all suggest that a better-specified model would also analyze media use, task requirements, and performance at the level of the work group or work unit (Morrow 1981). Indeed, while the results for the voice mail 1 sample here provide little if any support for H1b, similar analyses of this sample conducted using the work

groups as the unit of analysis found considerably stronger results. Nearly 60% of the variance in T1-T2 changes in performance (measured at T2, a half-year after implementing voice mail) was explained, using computer-monitored measures of usage in work units with analyzable and unanalyzable task environments (measured at T1, before the implementation) (Rice and Shook 1990b).

An underlying question still remains: to what extent is media choice, use and evaluation intentional, conscious or "rational"? The present study is not about media *choice* at all, but about relationships of tasks and performance with media *use*, regardless of intentionality of choice or the extent to which the respondent surmised the relative media richness or social presence of various media summarized in Table 1. If Daft et al. (1987) and Rice et al. (1989) are right, however, then the results in the present study would be stronger were the extent of media awareness and intentionality of media choice also specified in the analyses. That is, both "media use" and "media awareness" should be explicitly integrated into a more comprehensive model of the choice, use, and outcomes of organizational communication channels.

Finally, keeping in mind all the limitations and uncertainties of this study, how do the present results reflect on two of the recommendations for media use proposed by Lengel and Daft (1988), and listed below? Their recommendations are based on the results of the Daft, Lengel and Trevino (1987) study, which found a Chi-square association between media awareness and performance of 5.4 ($p < 0.02$). A reanalysis of their published data shows that the asymmetric Lambda is 0.10—that is, media awareness accounted for approximately 10% of the reduction in error in predicting performance. The average percentage of variance explained in the regressions for the four media studied here was 11%, and the average percentage of variance explained by the correlations was 14% ($r = 0.38$) in the "matched" task environments, and 4% ($r = 0.20$) in the "unmatched" environments. Results from both studies provide, at best, very moderate evidence for any prescriptions about which media to use in which situations.

"*Send nonroutine, difficult communications through a rich medium, preferably face-to-face.*" The only statistically significant correlations between media use and increased effectiveness in unanalyzable task environments occurred for information rich media, supporting this recommendation. However, the average percent of variance explained by use of information rich media in unanalyzable task environments was similar to the Daft et al. results. So, while the trend is correct, it would be unwise to follow this advice slavishly; the bulk of variance in performance is possibly explained by some of the other factors discussed above, as well as other, as yet unidentified influences.

"*Send routine, simple communications through a lean medium.*" This advice is supported by the results from the online database sample and the electronic mail sample. However, increased effectiveness in conditions of task analyzability is also associated with use of rich media for one of the voice mail 1 analyses, both of the voice mail 2 analyses, and one of the videoconferencing analyses. Thus this recommendation is based on the assumption of symmetry, which the present study (and, indeed, Daft et al's own study) does not support.

Qualifying these recommendations is especially relevant in the many typical communication conditions that present situational constraints. That is, the benefit of using new media in an analyzable task environment to overcome the many inherent constraints to communication (temporal, spatial, distributional, etc.) may well outweigh the theoretically potential threat of impaired communication or inefficient channel use associated with mismatches of medium and environment.

In the end, we agree with Lengel and Daft's most general recommendation:

"*Evaluate new communication technologies as one of many in a spectrum.*" We would add, however, (1) evaluate traditional media as part of that same spectrum, (2) new media may be used to good effect to overcome situational constraints even when its characteristics do not match the task's information processing requirements, (3) do not assume that media richness operates either nonmonotonically or symmetrically, and (4) do not rely too heavily on the media-task match to explain performance outcomes.

Conclusion

The results of this study, though providing only modest support, have at least two sets of theoretical implications. First, prior organizational information processing research may have lacked the empirical support that would befit their substantial theoretical contribution to organizational research because of problems with model specification. That is, while the models have considered the interface between context and capability as between generalized environments and organizations as a whole, the actual processing of most information occurs as people use specific media and operate within specific units. Further, traditional theories of organizational information processing have in the past tended to rely on a concept of information as objective (Rice 1989), and on a concept of performance as efficiency (Johnson and Rice 1987). Taking into account the importance of symbolic communication, negotiated meaning, interpretation of ambiguous situations, equivocal decision-making and the importance of unit context, it is easy to see that communication between individuals and within groups is the crux to achieving increased effectiveness.

Second, while communication plays a central role in theories of organizational communication, the nature of the communication media has received insufficient attention. Reliance on standard conceptualizations such as dichotomies between interpersonal and mass media, superior and subordinate flows, or formal and informal content, has institutionalized the notion that face-to-face communication is the ideal and that mediated communication, especially computer-mediated communication, is a poor substitute (Culnan and Markus 1987). Instead, it is important to understand how each communication channel has its advantages and disadvantages, how it may increase or reduce constraints on communication, and how its effectiveness is contingent on a wide array of factors, including task requirements (Rice 1987). These and related results show that there is a developing consistency to characterizations of organizational communication media. These differences may contribute to better specifications of processes and relationships in theories about organizational communication and performance, as well as better understanding of the potential roles of new organizational media.

Acknowledgements

The authors thank Dr. Bob Zmud and anonymous reviewers for their comments on previous drafts of this paper. We especially thank Dr. Jolene Galegher for her extensive editorial and substantive suggestions. We also thank the many respondents and contacts from the various organizations who participated in the studies.

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