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The role of information technology in the organization: a review, model, and assessment

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Abstract

This paper reviews and extends recent scholarly and popular literature to provide a broad overview of how information technology (IT) impacts organizational characteristics and outcomes. First, based on a review of the literature, we describe two of the principal performance enhancing benefits of IT: information efficiencies and information synergies, and identify five main organizational outcomes of the application of IT that embody these benefits. We then discuss the role that IT plays in moderating the relationship between organizational characteristics including structure, size, learning, culture, and interorganizational relationships and the most strategic outcomes, organizational efficiency and innovation. Throughout we discuss the limitations and possible negative consequences of the use of IT and close by considering several key areas for future research.

1. Introduction

The availability and use of information systems and technologies has grown almost to the point of being commodity like in nature, becoming nearly as ubiquitous as labor. By 1991, U.S. companies spent more on information technology than any other form of investment; total spending on computers and related services doubled from approximately $80 billion in 1984 to over $160 billion in 1998 (Taylor, 1998). *Information systems* include many different varieties of software platforms and databases. These encompass enterprise-wide systems designed to manage all major functions of the organization provided by companies such as

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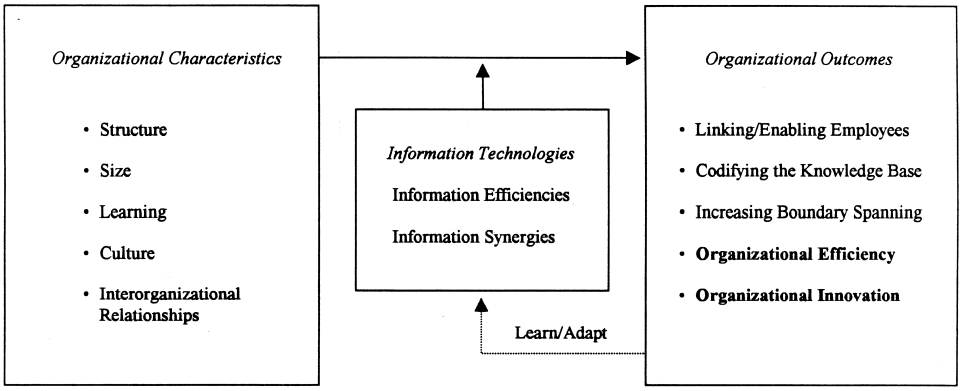

Fig. 1. The role of IT in the organization.

SAP, PeopleSoft, JD Edwards, and so on, to more general purpose database products targeted towards specific uses such as the products offered by Oracle, Microsoft, and many others (e.g., Evans, 1999; Hickman, 1999; Kathleen, 1999; McKendrick, 1999; Menezes, 1999). *Information technologies* encompass a broad array of communication media and devices which link information systems and people including voice mail, e-mail, voice conferencing, video conferencing, the internet, groupware and corporate intranets, car phones, fax machines, personal digital assistants, and so on (e.g., Andolsen, 1999; Campbell, 1999; Edwards, 1999; Grahm, 1999; Schober, 1999; Spiegelman, 1999; Tarabour, 1999; Wildstrom, 1999). Information systems and information technologies are often inextricably linked and, since it has become conventional to do so, for the rest of this paper we will refer to them jointly as information technology (IT).

Recent scholarly and popular literature has examined the role that IT plays in promoting collaboration and information sharing both inside and across organizational boundaries (e.g., Barua, Sophie Lee & Whinston, 1995; Lind & Zmud, 1995; Pickering & King, 1995; Quinn, Anderson & Finkelstein, 1996a). In this paper we draw on recent IT management literature to systematically review and assess the role of IT in the organization. Our paper builds on Huber's (1990) suggestion that IT is a variable that can be used to enhance the quality and timeliness of organizational intelligence and decision making, thus promoting organizational performance. However, Huber's analysis was offered at a time when IT was making its first major inroads into organizational life and the current paper extends and updates Huber's research in three main ways. First, building on recent research, we focus on the two strategic outcomes of efficiency and innovation which capture many of the specific benefits that result from the use of IT. Second, we apply this approach to the examination of organizational functioning by describing the impact of IT on a broader array of organizational characteristics than was addressed in Huber's work. Finally, Huber's theory treats several organizational characteristics as dependent variables with IT positioned as the independent variable. In order to offer a more encompassing view of IT and organizational functioning, we examine IT as a moderator of the relationship between organizational characteristics and several organizational outcomes, most importantly, efficiency and innovation (See Fig. 1). We believe this approach both places IT in a more theoretically plausible position and offers

a useful framework that allows for the discussion of IT and a larger array of strategic organizational issues.

The list of potential salient organizational characteristics that impact organizational outcomes is lengthy. We have chosen to highlight those that have been suggested by previous research, are important to organizational performance, and clearly related to IT. Similarly, many possible organizational outcomes could be addressed, but those of efficiency and innovation also emerged from our review of previous research as having the most performance-enhancing potential in relation to IT. The justification for posing IT as a moderator in the model can be seen when one considers that non-IT enabled structural dimensions, information sources, communication processes, and so on, already serve to facilitate the link between organizational characteristics and outcomes. It is our contention that, in general, IT serves to alter or change the impact of these organizational characteristics on outcomes, thus moderating their effect in the model.

Finally, the feedback loop connecting organizational outcomes to IT in the figure serves to recognize a temporal reality in the application of any new technology. Optimally fitting a given IT to its context and ramping up the learning curve associated with the IT (Orlikowski, Yates, Okamura & Fujimoto, 1995) both require continuous and/or periodic modifications to ensure the IT's maximum utility. However, the use of IT is not a panacea (Constant, Sproull & Kiesler, 1996; DeSanctis & Monge, 1999). It has long been noted that the use of IT can lead to undesirable side effects (e.g., Culnan & Markus, 1987; DeSanctis & Monge, 1999; Zuboff, 1988). When we consider that some traditional means of communication often score higher than advanced technologies with respect to acceptability, ease of use, and richness (e.g., Trevino, Lengel & Daft, 1987), it becomes clear that the effects of IT are not universally positive, but that when they are applied appropriately they can serve as a powerful addition to an organization's communications infrastructure (Huber, 1990). We address this reality by noting several potentially negative outcomes associated with IT throughout the paper.

2. IT: information efficiencies and information synergies

In the 1960s and 1970s, when many definitions of organizational technology were being developed, IT was largely nonexistent with computers being almost entirely confined to the world of mainframes and backroom functional applications. Technology was conceptualized in terms of technical complexity (Woodward, 1965); operations technology and variability (Pugh, Hickson, Hinings & Turner, 1969; Hickson, Pugh & Pheysey, 1969); interdependence (Thompson, 1967); routine-nonroutine (Perrow, 1967, 1970), and manageability of raw materials (Mohr, 1971). Following Perrow's (Perrow, 1967) suggestion, we propose that technology should be viewed broadly as the process of managing the uncertainty and risk surrounding the transactions necessary to convert inputs into outputs (Thompson, 1967). Given that today IT has become a primary means of managing and reducing the uncertainties surrounding production and administrative processes we see technology and IT as inextricably linked.

Clearly, a list of the specific ways in which IT impacts an organization would be lengthy

so we have chosen not to focus on the numerous specific capabilities IT affords organizations. Instead, based on a review of the literature, we identify several major outcomes associated with the application of IT, as noted in Fig. 1. Our detailed review of research on IT includes work within the last five years that has appeared in six leading management journals (*Academy of Management Journal, Academy of Management Review, Administrative Science Quarterly, Journal of Management, Organization Science, Strategic Management Journal*) and demonstrates the breadth of approaches scholars have used in this arena. In an effort to structure these works as a useful reference, we have organized them chronologically and by the primary benefit of IT that each focuses on, as will be discussed below. (See Table 1)

In addition, an analysis of this research leads us to argue that, at an even higher conceptual level of analysis, IT moderates the effects of organizational characteristics on outcomes through its ability to generate information efficiencies and information synergies.

Information efficiencies (INE) are the cost and time savings that result when IT allows individual employees to perform their current tasks at a higher level, assume additional tasks, and expand their roles in the organization due to advances in the ability to gather and analyze data. For example, as the result of the application of IT in the organization it is very likely that a reshuffling of tasks will occur as technologies increase peoples' or subunits' ability to process information. What before, for example, might have been a task that requires the inputs of three different people or subunits becomes a task that one individual or function can perform effectively because IT helps to increase both the amount and quality of information which can be adequately processed. As we have defined them, INE are largely a within-person or within-group effect. Thus, on the one hand, IT might simply allow each individual or subunit to perform more work, cumulatively providing a gain in organizational efficiency.

On the other hand, *information synergies* (INS) are the performance gains that result when IT allows two or more individuals or subunits to pool their resources and cooperate and collaborate across role or subunit boundaries, a between-person or between-group effect. For example, information synergies occur when IT allows the different individuals or subunits to adjust their actions or behaviors to the needs of the other individuals or subunits on an ongoing basis. In essence, information synergies arise when IT helps to promote the multiplicative and nonseparable gains that can be obtained from team-based cooperation (Alchian & Demsetz, 1972).

Bearing these two meta-benefits in mind, the five broad categories of organizational outcomes we have identified from our review of the literature are: improved ability to link and enable employees, improved ability to codify the organization's knowledge base, improved boundary spanning capabilities, improved information processing that leads to increased efficiency; and improved collaboration and coordination that promotes innovation. Below, each of these outcomes will be considered in turn as related to the concepts of INE and INS.

2.1. IT links and enables employees

As compared to face-to-face communication, the use of electronic communication has been shown in the literature to increase the overall amount of communication in the

Table 1
Recent information technology related management literature

Authors	Focus/Outcome examined	Type of IT	Theoretical approach	Analyses/ Level of analysis	Primary IT property addressed
Barua et al., 1995	IT design, incentives, organization and task characteristics: peer monitoring and pressure, individual effort, group performance	Group decision support systems	Group theories	N/A; group	A, D
Borland & Tenkasi, 1995	IT design, perspective making and taking: designing IT to support knowledge work	Electronic communication	Communication, language, cognition	N/A; varied	A, E
Dos Santos & Peffers, 1995	Application of IT: market share and income	ATM machines	Competitive advantage	Regression; organzation	D, E
Fulk & DeSanctis, 1995	Effect of IT: changing organizational forms	Communication technologies	Various organizational theories	N/A; varied	A, B, C, D, E
Hinds & Kiesler, 1995	Direction of use of IT, lateral versus horizontal by type of worker: pattern of communication media use by different types of employees	Electronic mail	Various organizational theories	Logit regression; individual	A, D
Leidner & Elam, 1995	Effect of IT on several organizational outcomes: decision making speed, problem identification speed, information availability, involvement of subordinates in decision making	Executive Information System	Huber (1990)	MANOVA, ANOVA; individual	A, B, C, D
Lind & Zmud, 1995	Effect of IT on interorganizational relationships and financial performance: satisfaction with dyadic partner interactions, dealership sales performance	Voice mail	Various organizational theories	LISREL, ANCOVA; inter-organization, Dyads	C, D
Orlikowski et al., 1995	IT management in R&D department: process of metastructuring	Electronic conferencing/messaging	Technology structuring	Descriptive; organization	A, B, D, E

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Table 1 *(continued)*

Authors	Focus/Outcome examined	Type of IT	Theoretical approach	Analyses/ Level of analysis	Primary IT property addressed
Pickering & King, 1995	Effect of IT on weak ties: use of inter-organization computer mediated communication	Inter-organizational computer mediated communication	Network theory, weak ties	N/A; inter-organization	A, C, D
Webster & Trevino, 1995	Determinants of Use of IT within an organization: choice of media	Electronic mail	Media choice/social influence	Policy capturing; repeated measures ANOVA, ANOVA, ANCOVA; individual	A, D
Weisband et al., 1995	Effect of IT on group status and participation: group member participation and influence	Computer mediated communication	Group status/social influence	ANOVA; group	A, B, D
Zack & McKenney, 1995	Determinants of Use of IT, social context and interaction: use of IT across contexts	Group authoring & messaging system	Network and organizational theories	Network analysis; group, network	A, B, D
Constant et al., 1996	Effect of IT on weak ties: usefulness of advice received	Electronic mail	Network theory, weak ties	Regression; individual	A, D, E
Lawler & Elliot, 1996	Effect of IT in human resource management: problem solving accuracy and efficiency, confidence in use of ES, perceived ease of use, task attitude	Expert system	Behavioral decision thepry	ANOVA, logistic regression; individual	B, D
Alavi et al., 1997	Effect of IT on management education: dimensions of learning experience for students and faculty	Video-conferencing, electornic group support systems	Inter-organizational Theories	Case methods, ANCOVA, individual	A, B, C, D
Ang & Cummings, 1997	Whether or not to outsource IT: degree of bank IS outsourcing	Various IS resources	Institutional theory	Logit regression; organization	D
Hart & Saunders, 1997	Determinants of use of IT between organizations, power and trust in adoption: EDI adoption and use	Electronic data interchange	Power and trust	N/A; inter-organization	C, D, E

(continued on next page)

Table 1 *(continued)*

Authors	Focus/Outcome examined	Type of IT	Theoretical approach	Analyses/ Level of analysis	Primary IT property addressed
Holland & Lockett, 1997	Effects of IT on network structure: mixed mode network structures	Inter-organizational systems	Mixed mode network theory	Case methods; inter-organization	C, E
Powell & Dent-Micallef, 1997	IT as a competitive advantage	IT technologies	Resource based view of the firm, competitive advantage	Regression; organization	A, B, C, D, E
Nault, 1997	Effect of IT in a horizontal network organization: increased franchisee profit, more horizontal franchise structure	Customer management system	Network theory	N/A; corporate, franchise	B, C, D
Swanson & Ramiller, 1997	Determinants of use of IT among organizations: adoption and diffusion of new IT	IT innovations	Institutional theory, organizing vision	N/A; inter-organization	E
Webster & Hackley, 1997	Effect of IT on distance learning: student involvement, cognitive engagement, technology self-efficacy, etc.	Distance learning technologies	Teaching effectiveness theories	Regression; individual	A, D
Anand et al., 1998	Role of IT in organizational memory: effective information management	Information and communication technologies	Organizational memory	N/A; individual, organization	A, B, D, E
Kraut et al., 1998	Determinants of use of IT within an organization: amount of video conferencing use	Video telephone system	Media richness theory, utility theories, social influence theories, contingency theory	Time series analysis; individual	A, D
Lado & Zhang, 1998	Effect of IT on competitive advantage: knowledge development and use, competitive advantage	Expert systems	Resource based view	N/A; organization	B, D, E
Sarbaugh-Thompson & Feldman, 1998	Effect of IT on intra-organizational communication: volume of communication, efficacy of communication	Electronic mail	Network theory, communication theories	Network analysis; network	A, D

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Table 1 *(continued)*

Authors	Focus/Outcome examined	Type of IT	Theoretical approach	Analyses/ Level of analysis	Primary IT property addressed
Argyres, 1999	Effect of IT on organizational identity: inter-firm coordination in product development	Telecommuting technologies	Transaction cost theory, agency theory, information processing theory	Case methods; inter-organization	A, B, C, D, E
DeSanctis & Monge, 1999	Application of IT in virtual organizations: varied (introduction to special issue)	Electronic communications technologies	Various organizational theories	N/A; individual organization	A, C, D
Griffith, 1999	Technology and sensemaking: sensemaking and adaptive structuration	Tools for instrumental action	Adaptive structuration, social construction	N/A; individual	N/A
Jarvenpaa & Leidner, 1999	Effect of IT on trust in virtual teams: trust	Internet, electronic mail	Trust	Descriptive; individual	A, B, D
Kraut et al., 1999	Effect on IT on outsourcing production: electronic network use, extent of outsourcing, perceived order quality, satisfaction with supplier	Electronic networks	Transaction costs theory	Regression; transaction, organization	A, B, D
Kurland & Egan, 1999	Role of IT in justice perceptions: justice	Telecommuting technologies	Justice theories	Regression; individual	A, D
Martins & Kambil, 1999	Effect of incumbent IT on new IT: threat/opportunity framing; effect certainty; response certainty	Technologies for filing tax returns	Strategic issue interpretation	Regression; individual	N/A
Mitchell & Zmud, 1999	Effect of IT coupling with process strategies on process innovation: project performance	IT technologies	Loose coupling, process innovation	Regression; individual	A, D, E
Staples et al., 1999	Effect of self-efficacy on IT for remote workers: individual performance, satisfaction, stress, etc.	Various information technologies	Self-efficacy	SEM; individual	A, D
Wiesenfeld et al., 1999	Effect of IT on organizational identity: organizational Idenification	Telecommuting technologies	Organizational identification	Case methods; individual	A, D
Yates et al., 1999	Effect of IT in an R&D group: emerging genres of use	Electronic conferencing/messaging	Genres of communication, technology-in-use mediation	Descriptive; user groups	A, B, D, E

Note: for primary IT property addressed: A = linking and enabling employees, B = codifying the knowledge base, C = increasing boundary spanning, D = promoting efficiency, E = promoting innovation, N/A = not applicable.

organization (Hiltz, Johnson, & Turoff, 1986). This implies what is perhaps the most fundamental benefit resulting from IT use in organizations; the ability to link and enable employees both within and between functions and divisions–whether through database repositories, teleconferencing, or electronic mail—and achieve INE and INS. For example, one of the most direct ways in which IT impacts organizational functioning is through its effects on horizontal coordination. The application of IT has been shown to aid cross-functional workflow (Monge & Fulk, 1995), concurrent engineering (Davidow & Malone, 1992), and stockless production (Piore, 1994). Increasing online interdependencies makes critical information more accessible and transparent to employees and increases the incidence of problem-solving (Edmondson & Moingeon, 1998). IT can also play an important role in allowing organizations to explore new modes of structuring their workforce. Several authors have also shown how IT successfully links employees in many emerging organizational forms, such as the virtual organization (Nohria & Berkley, 1994). For example, Kurland and Egan (1999) show that telecommuting increases employees' positive perceptions of both procedural and interactional justice. However, having to rely largely on IT for communication purposes in lieu of face-to-face communication can lead to increased alienation among employees (DeSanctis & Monge, 1999).

Although empirical research on these issues is just beginning, one example of the utility of information exchanged through electronic ties is provided by Constant, Sproull, and Kiesler (1996). They analyzed computer communications between information seekers and potential information providers at Tandem Computer Corporation. Their findings suggest information providers gave useful advice and solved the problems of information seekers, despite their lack of any personal connection with the seekers. This is supported by DeSanctis and Monge (1999) who argue that the only issue the literature shows consistent findings on is that divergent thinking tasks are completed more effectively electronically rather than face-to-face. Another example, from closer to home, is the Research Methods Network, a cyber meeting place created by the Research Methods Division of the Academy of Management. Through the service provided by the network, hundreds of scholars seeking assistance and resources relating to often complex research methodology questions are routinely assisted by the voluntary efforts of other scholars on the network.

The benefit of linking employees and creating information efficiencies has not been lost on industry. For example, at General Motors, senior executives became concerned about their process for using market information. They found that information about the kinds of vehicles that appeal to customers had not been used speedily or effectively within the company, especially during new product development and product launches. They determined that pertinent information was often available, yet was not acquired by the right employees in a timely fashion. In response to this problem the firm has implemented a new IT-based product development process which relies on a computerized "Inquiry Center" as a centralized source of market information, now ensuring that key employees are linked together throughout the process (Barabba & Zaltman, 1990).

It should be noted that simply serving as a link does not guarantee that IT will positively impact communication processes. It is also possible that even given the wide availability of weak tie linkages (Granovetter, 1973) due to IT, the motivation of some organizational members to provide information through these links may be low (Hanson, 1999). Nonethe-

less, there are several reasons to expect that sufficient motivation may be present. First, sharing expertise can increase a person's self-esteem, identification with the organization, respect from others, and feelings of commitment (Orr, 1989). Second, a person may be motivated through feelings of organizational citizenship (Bateman & Organ, 1983). In addition, a third explanation may be that the organization's culture has shaped norms which encourage the use of IT media, a topic we will address shortly.

The downside to linking employees must be noted as well. It is possible that not only the amount of good advice information seekers receive will increase, but bad advice may increase as well. Help seekers have no way of assessing the information providers expertise, motives, and so on (Constant et al., 1996). However, many firms work to ensure the reliability of information received via electronic weak ties by forming distinct on-line communities where collections of experienced employees within a given area can be located (e.g., a software developers forum, a sales force intranet, a manufacturing discussion group). By creating logical content communities, those who respond to information requests are in a sense prescreened as to the quality of advice they might offer (Davenport & Prusak, 1997; Kraut, Steinfield, Chan, Butler & Hoag, 1999).

Further, several authors have noted that the use of IT for communications purposes is still limited in that it does not allow users to obtain "soft" information (Mintzberg, 1975), "rich" information (Daft, Lengel & Trevino, 1987), or the "meaning" of information (Weick, 1985). Related to these ideas, Sarbaugh-Thompson and Feldman (1998) suggest that two possible negative effects of the use of electronic communication are the reduction in casual conversation and that it may lead to fewer opportunities to signal "communication trustworthiness" in social situations. These ideas suggest a deficiency in IT capabilities with respect to the depth of information exchanged. However, Huber (1990) disagrees and notes that these instances are much rarer than one might think. He cites research suggesting that communicators use a medium of communication that fits their needs (e.g., Daft et al., 1987), such that the IT used to communicate in a given instance is appropriate for the specific context or task. In addition, where one does wish to convey tacit information via IT, we would add that due to advances in technology the use of IT no longer precludes the capture of soft or tacit knowledge as several authors have warned. For example, IT applications allowing for the simultaneous use of audio and video media in group settings to convey messages is becoming widespread, overcoming earlier concerns that were based on single-media IT applications (e.g., electronic mail).

2.2. IT codifies the knowledge base

Memory is clearly fallible and subject to erosion and error; the human capacity for memory as a component of organizational memory is less than perfect (Huber, 1990). Inside an organization, memory has also been quite fallible because, as a collective of individuals, the firm is only able to maintain a minuscule portion of the information that is currently available to it. Advances in IT have greatly facilitated organizational memory and the ability to capture and integrate explicit knowledge by making it easy to codify, communicate, assimilate, store, and retrieve (Anand, Manz & Glick, 1998; Rockart & Short, 1989). What

this translates into is INE through an improved ability to apply past and current knowledge to issues facing the organization.

A good example of the utility of knowledge codification through IT is provided by Leidner and Elam (1995). They explore managers' use of executive information systems (EIS), a device with a single database repository that transmits, communicates, or processes company relevant information digitally for use in managerial decision making. Their empirical work suggests that when used frequently over time an EIS is positively related to problem identification and decision making speed for senior and middle managers. Similarly, Lado and Zhang (1998) examine expert systems (ES), computer systems specifically designed to help executives and managers make particular types of decisions. These systems store volumes of facts and heuristics and utilize software the makes interpretations of data or draws conclusions about a specific problem. The codification of knowledge allows critical documents to be stored on-line and discussions to be conducted online, building on the INE benefits of linking employees. In addition, electronic networks can maintain listings of employees and their area of specialization (Zorn, Marshall & Paned, 1997) allowing employees to identify and communicate with specialists whose expertise they may need (Senna, 1997), providing a context for collaboration, and potential INS.

Examples of knowledge codification and management in organizations are appearing rapidly. For example, at McKinsey and Company the need for accurate and timely information resources to support their consultants in the field has led to the creation of the Rapid Response Network. A group of experienced consultants assemble knowledge on-line from every level of the firm and then use in-house IT to disseminate information to consultants throughout the organization–information that would otherwise not have been available to them (Peters, 1992). Similarly, Chase Manhattan Bank has made document scanning and distribution the cornerstone of their knowledge management strategy. Their IT, Chase Information Exchange, enables all their bankers to use one single communications system to provide them with timely information and work with colleagues throughout the bank to solve client problems (Davenport & Prusak, 1997).

On the downside, given that the role of many information networks is to screen, package, and interpret messages, it is possible that IT can lead to information overload (e.g., DeSanctis & Monge, 1999; Huber, 1990). Sorting through such large amounts of data may impede managers' ability to make timely decisions. Nonetheless, there is reason to believe that this problem may not be as serious as some have claimed. Research by Hiltz and Turoff (1985) found that social norms and management practices develop over time to mitigate this problem. Leading technology and management consulting firms actively screen and manage the process of adding any information to the organizations' information infrastructure to ensure the proper size and utility of their information repositories. For example, Hewlett-Packard has adopted a pull strategy for information management whereby its vast repositories of online information are managed for size and utility. Document usage is measured by the department that "owns" the information in order to determine how long documents should remain in the repository (Davenport & Prusak, 1997). In addition, recent advances in IT have dramatically increased the ability of information seekers to search for and retrieve the precise information they are seeking, further mitigating the negative effects of data overload.

2.3. IT increases boundary spanning

In the case of boundary spanning activities, IT offers an organization substantial information efficiencies and synergies. From the perspective of the boundary spanner, IT does not just allow access to prior knowledge, as might result from knowledge codification, but allows an employee to search for and absorb new knowledge that is relevant to a problem at hand (Tushman, 1977). For example, in complex organizations employees working on one task or project may often wish to obtain useful knowledge residing in other operating units, but the employees may not know whether or not this knowledge exists and where it might reside. Organizational members are then faced with the need to search their network for information. Using Granovetter's (1973) arguments, Hanson (1999) describes how individuals or project teams use weak individual or interdepartmental ties to provide access to nonredundant information, information the focal unit did not have direct tie access to. Since messages transmitted via IT cut across personal and professional domains, individuals tend to maintain and monitor communications links (e.g., e-mail, voice mail) after hours and while they are away from the office which leads to an erosion of generally accepted personal and professional boundaries of time and space. Equipping large numbers of organizational members with communications links (e.g., internet access, intranet access, car phones, fax machines, audio and video conferencing) has dramatically expanded the access of any individual to various sources of information as well as increased their level of participation in various information networks (Yan & Lewis, 1999). IT thus helps eliminate labels suggesting that organizational members are boundary spanners or nonboundary spanners.

Simply providing access to new sources of information may create INE given time savings associated with information search. By allowing quicker access to both internal and external information, IT enables faster scanning and monitoring of the external environment (Rockart & DeLong, 1988), often an impetus for boundary spanning activity. In terms of INS, Feldman (1987) predicted that interorganizational electronic mail would greatly facilitate the establishment of weak ties. Pickering and King (1995) suggest that these IT enabled weak ties in interorganizational relationships create changes in personal social tie networks, links creating potential synergies for the organization. Thus, IT can provide employees with knowledge of industry best practices, information on relevant leading edge technologies, and the goings on at professional associations relevant to their work. In short, access to such rich boundary spanning information makes opportunities more salient. In terms of potentially negative effects of IT in this context, future research might consider the notion of decision speed or urgency. Given high decision urgency it is reasonable to speculate that information overload through codification and boundary spanning may be an impediment to expedient decision making. However, research examining decision environments suggests that decision speed is associated with the simultaneous consideration of many alternatives (Judge & Miller, 1991) and that fast decision makers actually use more information as compared to slower decision makers (Eisenhardt, 1989), although IT was not a major focus of this work.

2.4. IT promotes efficiency

As the previous discussion implies, and as Huber (1990) has argued, IT has many useful properties that can affect organizational efficiency. IT produces many efficiencies

in communication including the ability to communicate more easily and less expensively across time and geographic location; the ability to communicate more rapidly and with greater precision to targeted groups; the ability to record and index more reliably and inexpensively the context and nature of communication events; and the ability to more selectively control access and participation in a communication event or network. IT offers many decision-making efficiencies including the ability to store and retrieve large amounts of information more quickly and inexpensively; the ability to more rapidly and selectively access information created outside the organization, the ability to more rapidly and accurately combine and reconfigure information; the ability to more concisely store and quickly use experts' judgments and decision models; and the ability to more reliably and inexpensively record and retrieve information about the context and nature of organizational transactions.

Pickering and King (1995), for example, found that individuals using interorganizational electronic mail claimed that this technology reduces their information costs; and DeSanctis and Gallupe (1987) showed that IT reduces the cost of monitoring teamwork because it is easier to track progress when the group members have a common electronic workspace. Henderson and Venkatraman (1994) note two features of IT that directly address the issue of efficiency. First, IT offers dramatic increases in the speed of communication, with high volumes of data moving from one location to another at rates unimaginable even a few years ago. Second, IT dramatically reduces the costs of communication due to advances in computer and telecommunication technology that lead to economies of scale and scope. Finally, Argyres (1999) argued that IT reduces the cost of information processing, that is, the cost of sending and receiving information between actors, thus making some organizational structures more efficient than others.

Kuperman (1998) highlights the efficiency-enhancing role of IT in discussing the way his advertising firm, Chiat/Day, uses IT. An advertising agency's core competence is primarily based on its employees' skills and competencies and on organizational routines and a common language. So, to build on and enhance these competencies Chiat/Day's IT was designed to promote collaboration and information sharing. No longer must information move from person to person sequentially, rather knowledge is posted online and the system notifies the right person that a file or advertising copy has been delivered to them. As a result, their old giant manila sacks and mechanical files have been replaced by "electronic job jackets" containing all needed information and digitized photographs. This procedure has completely eliminated the traditional role of "traffic managers" and greatly increased the time efficiencies of their common routines. These kinds of efficiency gains are most commonly measured in terms of their effect on labor productivity, and the increases in labor productivity that have occurred during the 1990s are usually seen as a principal benefit to be gained from the application of IT in organizations (e.g., Greenspan, 2000).

2.5. IT promotes innovation

Myers and Marquis (1996) define innovation as "a complex activity which proceeds from the conceptualization of a new idea to a solution of the problem and then to the actual

utilization of economic or social value." Kanter (1983) views innovation "as the process of bringing any new problem-solving ideas into use." West and Farr (1990) define innovation broadly to "include the intentional introduction and application within a role, group, or organization of ideas, processes, products or procedures, new to the relevant unit of adoption, designed to significantly benefit the individual, the group, organization, or wider society." Our review of the IT literature leads us to the conclusion that the role of IT in promoting innovation is very underrepresented in the literature because of the focus on its efficiency-enhancing properties. For example, in the literature highlighted in Table 1, efficiency, especially when coupled with one or more of the three other outcomes moderated by IT, is addressed almost three times as much as innovation. As we suggest in the remainder of the paper, however, IT is an important but neglected means of facilitating the innovation process. This is because IT moderates many aspects of the process of bringing "new problem-solving ideas into use" given that it determines the way information is stored, transmitted, communicated, processed, and acted upon.

INE facilitates innovation by improving the initial base of knowledge to draw from when employees engage in problem solving and decision making. This creates a larger and richer pool of codified knowledge for any given employee to draw from, reducing the cost of information search. However, knowledge or information availability alone will not lead to innovation; it is the ability to creatively use knowledge that is the key to promoting innovation and creating competitive advantage (Leavy, 1998). Prahalad and Hamel (1990), for example, suggest that it is not the absolute level of knowledge a firm possesses which leads to competitive advantage, but the velocity with which it is circulated in the firm. Knowledge optimization speaks directly to INS. Recognizing that knowledge is often inextricably linked to human resources and the way individuals and groups interact, the information synergies possible through IT will only be realized when the firm is able to move further and actually utilize knowledge in its optimal location within the organization. This implies that organizations must move beyond knowledge circulation as described by Prahalad and Hamel (1990) and actually reallocate knowledge resources to the place where they can add the highest value to the organization as the need arises.

Project based work provides a vivid example of this process. As a project progresses, the need for particular team members waxes and wanes. Some employees will be part of a project from beginning to end and others will only be asked to participate at key times when their expertise is required. IT provides management with the real-time capability to monitor project progress and needs and allocate knowledge resources accordingly in an effort to optimize the overall value added of each employee, and, in turn, optimizing knowledge use and the potential for INS. In this vein, Davidow and Malone (1992) argue that traditionally, product design has involved sequential processing across functions, with handoffs as each stage of the process is completed. This linear process is being replaced by parallel processing and concurrent engineering made possible through the application of IT, allowing employees to work simultaneously with continual interaction through electronic communication, which can promote innovation.

As another example of how IT can promote innovation, Amabile (1988) argues that beyond a person's cognitive style or intrinsic motivation, a person's domain relevant skills are a vital input into creative, innovative activity. Domain relevant skills include a person's

factual knowledge, technical skills, and special talents in the domain and represents the individual's complete set of response possibilities from which a new response is to be synthesized. The ability of IT to enhance a person's domain relevant skills is an important input into the innovation process. To the degree that IT enhances the knowledge base available to each employee (INE) and allows these employees to work together (INS), innovative potential is increased. For example, consultation through informal lateral channels improves employees' ability to keep up with changes in techniques and new knowledge, helping them understand and adopt innovations (e.g., Abbott, 1991; Rice & Aydin, 1991). Constant et al.'s (1996) study examining the impact of advice offered through electronic weak ties also supports the idea that IT can build domain skills. They found that electronic weak ties offered information seekers useful technical information or referrals. Information providers gave valuable advice and helped solve the problems of information seekers despite the lack of personal relationship with requesters.

At a more macrolevel, as discussed earlier, IT is changing organizational forms and promoting creativity and innovation inside virtual organizational forms. Some authors suggest that the real power of IT enabled virtual forms is when relationships among electronically connected people or firms produce new and/or qualitatively different communication that yields product or process innovation (Ring & Van de Ven, 1994). For example, one type of IT-enabled interorganizational relationship noted by Venkatraman (1994) is knowledge leveraging, the sharing and integrating of expertise within a team or partnership through real-time, interconnected IT. Some benefits from these arrangements include the development of cross-functional synergies which may result in competitive advantage in the form of product or service differentiation. Unlike more rigid bureaucratic organizational forms, new IT-enabled forms are viewed as more innovatively responsive to varied environmental pressures such as heightened market volatility, the globalization of business, increased uncertainty, and demographic changes in labor and consumer sectors (Daft & Lewin, 1993; Halal, 1994; Heydebrand, 1989).

As in the case of efficiency, the ways in which IT can promote innovation are only now being discovered. IT enhances the possibilities of furthering creative and coordinated behaviors at all levels both inside and between organizations, a topic we turn to next.

3. IT: The link between organizational characteristics and organizational outcomes

In this section we address the other component of our conceptual model, the role IT plays in moderating the relationship between organizational-level characteristics and the organizational outcomes we have just identified and reviewed. Specifically, we consider how IT moderates the effects of organizational structure, size, learning, culture, and interorganizational relations on the two most strategic organizational outcomes just discussed, efficiency and innovation. Since research concerning these issues is in its infancy, our discussion below should be treated as a series of concerns, suggestions, or assertions that future researchers might find useful as a guide to the way they frame their research studies.

3.1. Structure

Research linking organizational structure to outcomes such as efficiency or innovation has always resulted in conflicting research findings because of the existence of contingency factors such as the environment, strategy, or technology that may affect the nature of the relationship (Child, 1972; Fry, 1982). For example, in relation to innovation, Damanpour's (1991) research addressed what many scholars have suggested are inconsistent findings (e.g., Dewar & Dutton, 1986; Kimberly & Evanisko, 1981; Zmud, 1982). His meta-analysis of over forty studies found that specialization, formalization, centralization, and vertical differentiation were all meaningfully correlated with innovation such that innovation was promoted in more organic organizational settings. Drawing on Damanpour (1991), who in turn drew on the work of earlier organizational theorists (e.g., Blau, 1970; Pugh, Hickson, Hinings, MacDonald, Turner, & Lupton, 1963), the way IT moderates the effects of these structural dimensions on organizational outcomes is discussed below.

3.1.1. Specialization

Specialization typically refers to the number of different specialties or job types in a firm (e.g., Aiken, Bacharach & French, 1980; Hage & Aiken, 1967). Specialization typically leads to the development of subunit orientations that reduce peoples' abilities to understand the wider context within which they are contributing their skills and expertise (Lawrence & Lorsch, 1968). IT can mitigate this tendency by providing greater information access to specialists through such technologies as email, corporate intranets, access to the internet, and so on. Easier access to information sources provides INE. Thus, for any given decision they face, employees will be better able to understand how their decision options mesh with the other decisions being made that are most closely related to their own area of work, how they relate to firm goals and objectives, and how well their options align with industry practices. In the absence of IT, this knowledge is often only available afterwards and employees may make decisions without regard for their organizational-level implications (Ciborra & Lanzara, 1990). When employees have a wider, and more immediate, appreciation of the organization innovation is more likely because information that is potentially useful for a given innovative effort is only as useful as it is timely and can be quickly assimilated (Barabba & Zaltman, 1990).

Further, consider the model of innovation noted earlier by Amabile (1988) where one of the main organizational factors impacting innovation is resources in the task domain. Amabile argues that resources in the task domain (defined as an area targeted for innovation) include people with knowledge of the feasibility of implementing particular innovations, people who have familiarity with relevant markets, and people with other types of relevant experience in the domain. All of these resources are knowledge based, innovation requires the contribution of specialist knowledge, and in as much as IT can help to overcome the distance between specialists, innovative potential will increase.

3.1.2. Formalization

Formalization is the process of developing routine responses to recurring problems or opportunities that specify how individuals and functions are to coordinate their actions to

accomplish organizational goals (e.g., Aiken et al., 1980; Blau & McKinley, 1979; Ettlie, Bridges & O'Keefe, 1984). Formalization can be achieved through the use of rules and standard operating procedures and through the development of common and shared norms and values (Weber, 1947). Fundamentally, formalization speaks to the desire for less ambiguity and more efficiency (Perrow, 1986), goals that IT is particularly suited to address. IT facilitates the recording and retrieval of information about organizational events and activities making the control of behaviors and processes through formalization more viable (Huber, 1990). IT offers the ability to diminish the negative effects of formalization - the cost of search associated with locating company resources detailing relevant standards and procedures. To the degree that IT leads to INE by reducing search times and interruptions in workflow, the administrative cost of formalization is reduced, increasing efficiency, and by contributing to slack resources this can be beneficial to the pursuit of innovation (Daft & Becker, 1978; Miller & Friesen, 1982).

Support for this perspective is provided by Groth (1999) who analyzed the way IT affected the development of the Boeing 777. The 777 was the first aircraft which was completely designed using real-time IT that coordinated the activities of over 5000 people at over twenty sites in two different countries. Boeing's new IT system managed thousands of drawings and documents which were studied, evaluated, updated, and changed constantly. Subsequent use of this system has allowed Boeing to create custom versions of the aircraft in 18 months compared to the traditional average of 52 months (Groth, 1999).

3.1.3. Centralization/decentralization

Centralization refers to the extent to which decision making authority is dispersed or concentrated in an organization (Pfeffer, 1981). Traditionally, input into corporate and operational strategies has been the domain of top management. Because of increased domestic and global competition throughout the 1990s, many firms have begun to move strategic decision making lower in the organization to take advantage of specialized workers who possess more accurate and timely local information (e.g., Fulk & Dutton, 1984). IT directly improves such endeavors in two major ways. First, they result in INE because they increase local information by supplementing it with more intimate knowledge of consumer and market trends and opportunities. For example, IT in customer support centers directed at solving customer problems via the internet has become a widespread means of increasing efficiency. Second, IT can produce INS because they facilitate increased communication and coordination between decentralized decision makers and central planners and upper management such that local action does not necessarily become more fragmented with respect to corporate goals as decision making authority moves lower in the hierarchy, but may actually become better aligned.

A more fundamental question is whether or not IT will lead to centralization or decentralization. In terms of centralization, by enabling managers to obtain more information, more quickly and accurately, management information systems reduce uncertainty and lead managers to make decisions that they otherwise may not have made (e.g., Blau, Falbe, McKinley & Tracey, 1976; Child & Partridge, 1982; Lado and Zhang, 1998). In contrast, decentralization through other forms of IT (e.g., electronic bulletin boards and discussion groups) enable lower and middle level managers to stay better informed about the organi-

zation's overall situation and about the nature of current problems and issues allowing them to be more globally optimized in their work (e.g., Argyres, 1999; Fulk & Dutton, 1984; Dawson & McLoughlin, 1986; Lawler, 1998; Zenger & Hesterly, 1997).

The literature suggests that IT can thus enable both centralization and decentralization. Scholars seem to agree that the use of IT allows organizations to place decision making authority across a greater range of hierarchical levels without sacrificing decision quality or timeliness (e.g., Groth, 1999; Huber, 1990; Keen, 1990). Keen (1990) combined the notions of centralization and decentralization in what is termed a federated organization where organizations no longer have to choose between centralized and decentralized modes of organization; IT permits simultaneous centralization-with-decentralization (e.g., Burris, 1993; Keen, 1990). The effect is to move authority towards that part of the organization where the pertinent information is to be utilized to make informed decisions, supporting what we have referred to as INE. The link between this line of reasoning and INS may be found in the literature on ambidextrous organizations which attempt to simultaneously sustain different organizational architectures in order to nurture multiple types of innovations (e.g., Tushman, Anderson & O'Reilly, 1997) suggesting that different types of innovative outcomes require different types of communication and collaboration processes.

3.1.4. Vertical differentiation

Vertical differentiation is a function of the number of levels in the organizational hierarchy (Damanpour, 1991). Extending the arguments on centralization and decentralization above, one of the most powerful ways IT moderates vertical differentiation is its ability to produce INE that allow fewer levels in the hierarchy to handle as much or more problem solving and decision making, resulting in a flatter organization. IT systems, by increasing the level of formalization or allowing "controlled" decentralization can act as a substitute for the control typically provided by a hierarchy. In addition, since IT provides lower-level employees with more freedom to coordinate their actions, this results in INS as employees can experiment and find better ways of performing their tasks. Support for this notion is found in the increasing incidence of flat, empowered, organizational structures with virtual organizations being an extreme case of low-cost organization that has begun to materialize (e.g., Shao, Liao & Wang, 1998; Snow, Lipnack & Stamps, 1999).

Thus, the link between IT, vertical differentiation, and innovation is evident in that innovation requires the sharing of information and the ability to mobilize action towards problem solving. To the extent that IT reduces the flow of information across vertical levels and knowledge flows more freely cross-functionally (Monge & Fulk, 1995), and in concert with more flexible decision making authority across levels (Keen, 1990), opportunities can be acted on more proactively.

3.2. Size

Numerous forms of network organization, based on the application of different types of IT, have begun to appear including the inverted organization, the spider's web, and the starburst (Quinn, Anderson & Finkelstein, 1996b; Ensign, 1999; Grandori, 1997; Miles & Snow, 1995). Since network organizations permit firms to increase the value they can create

while forgoing the need to increase in size (in terms of numbers of employees or assets), several authors (e.g., Groth, 1999; Fulk and DeSanctis, 1995) have suggested that IT may limit or even reduce firm size in the traditional sense. For example, Brynjolfsson, Malone, Gurbaxani and Kambil (1994) find broad support for the contention that investments in IT are significantly associated with decreases in the average size of firms across several measures of size. They suggest that one explanation is organizations' increasing reliance on markets for coordinating value creation activities following investments in IT, such as the growth in business-to-business networks.

In addition, others have argued that IT reduces size because INEs will lead to fewer numbers of middle managers (e.g., Groth, 1999) as the role of subordinates who provide the analysis that supports high-level decision making is reduced (Rockart & DeLong, 1988). This thought is echoed by Fulk and DeSanctis (1995) who suggest that the most common observation in the discussion of new organizational forms is the dwindling ranks of middle manages and administrative support. The ability of IT to facilitate a reduction in workforce size has been shown repeatedly. For example, a textile fibers division of DuPont was one of the first to adopt early retirement incentives in an effort to downsize. Unexpectedly, about half of the divisions middle tier of managers decided to take the early retirement package. DuPont executives now claim that if it were not for their newly installed electronic mail system they might not have survived the loss of so many managers at one time (Davenport & Prusak, 1997).

On the other hand, recent literature examining the effect of IT on firm size (Huber, 1990) combined with an examination of modern industry trends towards merger and acquisition of even the largest companies, for example, oil and gas or entertainment, suggests that IT may allow organizations to become bigger without any sacrifice of efficiency or innovativeness; indeed larger size may lead to economies of scale in managing input and output transactions. There has been little or no research into these issues, and future research needs to take into account the fact that in some instances although firms may be growing larger in terms of the number and scope of their activities so that the *number* of internal decision making units increases; the *size* of the units themselves may be shrinking because of the effect of INEs noted above.

3.3. Learning

In an effort to achieve success in uncertain, dynamic environments practitioners and scholars alike have focused attention on the concept of learning because organizational learning is a key antecedent of innovation (Hurley & Hult, 1998). In industry, this trend has become highly visible. Chief Knowledge Officers and Chief Learning Officers have appeared at Coca-Cola, General Electric, Sequent Computer, Young & Rubicam, and many leading consulting firms such as Ernst & Young, Coopers & Lybrand, and Booz-Allen and Hamilton (Davenport & Prusak, 1997) as "knowledge management" becomes increasingly in vogue. In a similar vein, techniques to increase organizational efficiency, such as those that comprise total quality management (Reger, Gustafson, Demarie & Mullane, 1994) are all dependent on the ability of managers and workers to learn and assimilate new ways of thinking and behaving. IT can play an important role in these processes by providing employees with easy

and flexible access to information and by facilitating problem solving, thus promoting learning (e.g., Huber, 1990; Malone & Rockart, 1991).

Perhaps the most relevant treatment of the learning construct in regards to IT is the concept of absorptive capacity. Cohen and Levinthal (1990) define absorptive capacity as a firm's ability to recognize the value of new external information, assimilate it, and apply it commercially. They argue that this ability is premised on the organization's level of prior existing knowledge - which includes factors such as basic skills possessed by employees, the common language they share and also includes knowledge of the most recent scientific or technological developments in a given field. Thus when IT, through INE and INS, promotes learning derived from absorptive capacity this may result in increased organizational efficiency and innovation. For example, IT may generate an increased ability to process new knowledge and promote product development (Nonaka, 1990); the reconfiguration of existing knowledge to form architectural innovations (Henderson & Clark, 1990), and so on.

Absorptive capacity has two dimensions, knowledge assimilation and knowledge integration (Cohen & Levinthal, 1990). With regard to knowledge assimilation, Cohen and Levinthal (1990) suggest firms should collect many sources of internal and external information. The use of IT (e.g., electronic mail, use of the internet to meet as part of on-line associations or to subscribe to third party data sources) provides the requisite boundary spanning capabilities to collect relevant information and offers INE relative to traditional means of collecting such data. The use of IT for codification purposes translates this information into a more widely accessible format for use by the organization, another result of INE. With respect to knowledge integration, various IT applications (e.g., groupware, project management programs, video conferencing) provide an infrastructure through which to integrate and circulate knowledge to achieve knowledge optimization, building the potential for INS and innovation. Here it is important to recognize that a firm's absorptive capacity is not simply the sum of individual's absorptive capacity, rather it depends on the ongoing exchanges of individuals embedded in organizations who continually share their knowledge and expertise, building upon the notion that information sharing is critical to organizational knowledge since intellectual assets, unlike physical assets, increase in value with use (Quinn et al., 1996a).

3.4. Culture

Culture can be defined as a complex pattern of beliefs, expectations, ideas, values, attitudes, and behaviors shared by the members of an organization (Trice & Beyer, 1993). IT facilitates the sharing of beliefs, values and norms because it allows for the quick and vivid transmission of rich information between people and subunits. Hence, IT can moderate the effects of culture on employee attitudes, beliefs, values, and behaviors in several ways.

IT can help enhance the motivational effects of cultural values that are supportive of efficiency or innovation. Using IT an organization can make available to employees a slew of supportive messages and statements, often contained in an organization's mission and vision, corporate goals, strategies, operating procedures, and so on. Email, voicemail, and intranets, for example, provide mechanisms for transferring and disseminating information about the organization to employees and can help promote the cultural shared norms, values,

and expectations that can facilitate support for efficiency or innovation. Increased exposure to colleagues' efforts; the richer information context stemming from an increasing number of possible information sources, and access to more individuals to collaborate with, increases the potential for INE and INS. To the extent that organizational members perceive that their use of IT is increasing their effectiveness in fulfilling organizational goals, their use of IT will become self-reinforcing (Huber, 1990). Over time this implies possible changes and modifications in the use of IT as employees find new and appropriate uses for the technology, as noted in our conceptual model.

Note that IT can be used to accomplish very different outcomes depending on the value attributed to the outcome (Leidner & Elam, 1995). As a result there is a need for a cultural understanding of IT in the organization. For example, Zack and McKenney (1995) explored the use of computer-mediated communication (CMC) and concluded that past research has too often assumed that given an appropriate design, once the IT is implemented, communications processes and patterns will change in the desired and intended ways. They disagree and note that rarely is the culture or social context that is required to support the IT examined. Whether on not a given IT moderates the effects of culture on organizational outcomes depends on the particular social circumstances in which the IT is applied (e.g., Fulk & Boyd, 1991). Zack and McKenney (1995) demonstrate that distinct groups within an organization can have very different patterns of IT use given the different culture or social context within which they are embedded (controlling culture not conducive to sharing information vs. a commitment oriented culture providing clear support for the sharing of information).

For new communications media, social explanations of use are important given that standard ways of communicating by these means have not yet become fully institutionalized (Sitkin, Sutcliffe & Barrios-Choplin, 1992; Webster & Trevino, 1995). For example, over time, as employees develop attitudes towards a new IT and beliefs about its usefulness, the symbolic meanings imposed by peers and superiors will be instrumental in determining organizational outcomes. For example, Isaksen, Lauer and Ekvall (1999) suggest that when employees feel welcome to present new ideas and express a wide variety of viewpoints this will make the organization supportive of innovation. Research has demonstrated that shared values can promote an organizational culture that spurs innovation and change (e.g., Scott & Bruce, 1994). And, as noted earlier, IT facilitates the sharing of values and norms between people and subunits.

3.5. Interorganizational relations

The existing literature suggests several ways in which IT can moderate the effects of interorganizational relations on organizational outcomes. This is a topic that is likely to prove very significant for future research given the promise that business-to-business networks hold for increasing organizational efficiency and innovation (e.g., Cohen & Brady, 2000; Hof & Smith, 2000; Taylor, 2000). For example, Venkatraman (1994) has identified four categories of IT enabled interorganizational relationships: transaction processing (e.g., EDI), inventory movement (use of IT to move materials or information about inventories across organizational boundaries), process links (connect interdependent processes such as design and engineering across organizational boundaries), and knowledge leveraging (focuses on shar-

ing and leveraging expertise within a partnership). Similar to the situation inside an organization, one of the most obvious gains from IT in an interorganizational context is the cost savings that stem from the ease with which information can be transmitted and utilized, a form of INE (Zaheer & Venkatraman, 1994). Malone, Yates and Benjamin (1987) suggest that interorganizational electronic networks reduce the transaction costs associated with the search, evaluation, and monitoring of competing suppliers, often making market-type arrangements more attractive than hierarchies. In addition, they argue that firms use electronic networks not only to reduce governance costs but also because they increase the pool of potential suppliers, reducing firms' exposure to opportunism. Although several authors support these ideas (e.g., Kekre & Mudhopadhyay, 1992), Kraut, Steinfield, Chan, Butler and Hoag (1999) found that greater use of electronic networks with suppliers was associated with poorer outcomes than when using traditional mediums of coordination, suggesting the need for further research to identify salient contingencies.

IT may also play a role in moderating the way interorganizational relationships interact with firm size. Interorganizational relationships are increasingly being supported by communication systems that obviate the need for one firm to subsume another (Fulk & DeSanctis, 1995). Empirical work supplied by Brynjolfsson et al. (1994) supports this position and shows that firms investing heavily in IT to facilitate interorganizational relationships are significantly smaller in staff size, holding other measures of size constant.

Partnership relations are also impacted by IT. For instance, aside from electronically linking backwards with suppliers, firms may use IT to link forward in the value chain to connect its operations with those of customers, something which reduces their costs and creates a disincentive for customers to seek other suppliers (Fulk & DeSanctis, 1995). Strategic alliances of various forms are becoming common today and not simply among business with similar value chains. Increasingly, IT is being used in strategic alliances to break down barriers between industries and to link divergent value chains, creating INE and INS (Fulk & DeSanctis, 1995; Norman & Ramirez, 1993). An additional perspective on how IT can enhance the effects of interorganizational relationships can be seen in how firms manage various structural parameters of partnerships. For example, specialization between organizations can be facilitated through the application of IT. Increasingly, it is believed that interorganizational links build innovative capabilities by providing opportunities for various types of INE including the transfer of technical knowledge and other resource exchanges (Nohria & Eccles, 1992). Such linking of disparate specialists provides the opportunity for formalization between organizations as well. Just as on-line formalization can reduce disruptions to workflow within a single organizations, so to can it benefit interorganizational relationships, as for example, between a firm and its suppliers or customers, and help to increase both efficiency and innovation. The use of common IT defines a clear means of ongoing communication; an agreed upon standard for storing and accessing alliance related work; and it creates a repository of all guiding goals, rules, and procedures which participants can reference -all gains in INE. To the degree that such tools streamline communication and standardize coordination, more time will have been gained for participants to collaborate on the actual task at hand, leading to potential INS.

IT may further facilitate synergies in support of innovative efforts in an interorganizational context through their relationship to learning. Alvari, Yoo and Vogel (1997) demon-

strated this ability of IT through an examination of management education. Their study of IT and education described the use of technology to design and deliver a graduate course at two universities which enabled collaborative learning, teaching with transcontinental student teams, and the use of multiple instructors. In an organizational setting, Feldman (1987) predicted that interorganizational electronic mail would greatly facilitate the establishment of weak ties to support information gathering and to facilitate problem solving. In addition, such links can be used to mobilize organizations that are alike to respond to common problems (Pickering & King, 1995). Employees from partnering firms coming together through IT to solve common problems is a prime example of INS and a direct impetus to innovation.

As we have noted in other areas, the effects of IT in this context are not expected to be universally positive. Consider the case of EDI once again. Hart and Saunders (1997) provide a theoretical treatment of EDI rooted in trust and power which concludes that firms with greater power can influence their trading partners to adopt EDI which might leave less powerful partners vulnerable to opportunism. Thus Hart and Saunders argue that over time this vulnerability can become a constraint that prevents improvements in coordination through expanded use of the system. However, when adopted as an opportunity and freely available to all comers, the use of EDI can provide partners with a platform upon which they can learn to trust and support one another and cooperate over process restructuring or changes in distribution processes that will enhance the performance of all the members of the network (Hart & Saunders, 1997).

4. Implications and conclusions

Our review and assessment of both the general categories of outcomes that may be promoted through the application of IT, as well as our discussion of how the relationship between organizational characteristics and outcomes may be moderated by IT, helps to reveal the rich research possibilities that lie ahead. We believe that the pace of IT change that has swept through the economy has left the academic community behind and that the definition, meaning, and current significance of many of the basic building blocks and theories of organizational studies need to be reexamined. The full implications of IT for most of the relationships and outcomes discussed in this paper are still evolving and will continue to do so as the application of new IT reshape organizational strategy and theory and force researchers to reevaluate the process of value creation. The remainder of the paper will highlight several important issues that are likely to arise in future research.

4.1. Competitive advantage and strategy

One noticeable absence in our review of the literature was research that examines the implications of IT for organizational strategy at any level of analysis. Theoretically it has been noted that IT must be tightly coupled with strategy (e.g., Holland, Lockett & Blackman, 1992; Porter & Millar, 1985) because IT affects strategy and strategies have IT implications (e.g., Bakos & Treacy, 1986), yet theoretical or empirical treatment of the way IT moderates the effects of strategy on organizational outcomes such as efficiency and innovation or

performance in general has not been a recent focus in top management journals. This is somewhat surprising given that IT can be instrumental in both shaping core capabilities and integrating capabilities into the organization context making them apparent at all organizational levels (Ciborra & Lanzara, 1990). Moreover, IT capabilities can be difficult to imitate since they are not just present in physical information systems, but in the organization-specific information technologies developed inside the organization over time. Hence, Wal-Mart's ability to protect what it regards as a core competency in IT by legally blocking the movement of some of its key programmers to dot.com's like Amazon.com (Schwartz & Salvatore, 1999).

Furthermore, competitive positioning and the ability to pursue a low cost and/or differentiation strategy ultimately depends on a firm's ability to increase efficiency, quality, innovation, and customer responsiveness (Porter, 1996; Prahalad & Hamel, 1990). Since IT moderates the way strategy affects performance, the implications of different forms of IT for both the pursuit of a strategy and for determining its effectiveness deserves consideration. For example, one advantage of IT is knowledge leveraging (Venkatraman, 1994) which involves sharing and integrating cross-functional expertise through appropriate forms of technology. Benefits from knowledge leveraging include the development of synergies and delivery to customers of value-added services and products, which in turn may result in competitive advantage in the form of product or service differentiation. The way in which Citibank implemented an organization-wide IT to increase responsiveness to customers is instructive. In 2000, Citibank set its goal to be the premier global international financial company. Studying its business processes it was clear that the main customer complaint was the amount of time customers had to wait for a response to their request, so it set out to solve this problem. Teams of managers examined the way Citibank's current IT worked, and then redesigned it to empower employees and reduce the "handoffs" between people and functions. Employees were then given extensive training in operating the new IT system. Citibank has been able to document significant time and cost savings as well as increase in the level of personalized service it is able to offer its clients which has led to a significant increase in the number of global customers (Rucker, 2000).

At the corporate level, we noted earlier how IT, by reducing the transaction costs between both corporate headquarters and divisions and between divisions, has allowed organizations to grow in the sense that the number of the decision making units has increased. IT also facilitates the sharing of knowledge and information not just inside divisions but also between divisions which may lead to a broader product range, for single business firms, and the ability to reap synergies or "product opportunities" for firms engaged in related diversification such as AOL-Time Warner or Sony.

4.2. The relationship between IT and organizational performance

Although it has been shown that announcements of innovative IT investments do have positive effects on the announcing firm's stock price (Dos Santos, Peffers & Mauer, 1993), several authors have suggested that actual returns to organizations from investment in IT are not sufficient to back up claims of their performance-enhancing advantages. Despite broad claims by experts like Greenspan (2000) that the performance gains—from both efficiency

and innovation—that stem from IT are one major cause of record firm-profits in the 1990s, some suggest that there is little evidence that investments in new IT applications have a positive impact on internal measures of firm performance such as market share or profitability (Dos Santos & Peffers, 1995) and that these dollars might be better spent elsewhere (Baily & Chakrabarti, 1988; Roach, 1987). The handful of studies that have examined the relationship between IT and firm performance (e.g., Cron & Sobol, 1983; Harris & Katz, 1991; Hitt & Brynjolfsson, 1996; Weill, 1992) have provided findings that tend to be either mixed or inconclusive. For example, Hitt and Brynjolfsson (1996) empirically demonstrated that increases in productivity do not necessarily translate into increases in profitability, as measured by ROI and ROA. Similarly, Floyd and Wooldbridge (1990) found no overall connection between ATM adoption and performance among banks, with a negative correlation between performance and process IT and a positive correlation between performance and product IT.

However, there are several reasons to suppose that these studies are not fine-grained enough to adequately capture and measure IT effects. First, as we have suggested in this paper, the effects of IT are indirect, specifically, we have argued that IT is a moderator of organizational characteristics and processes that typically already exist prior to the application of IT. For example, Powell and Dent-Micallef (1997) support this position by suggesting that IT will only lead to competitive advantage when they leverage or exploit preexisting, complementary human and business resources. In fact, Neo (1988) found that IT itself had less to do with IT success than did strategic planning and management vision and support. This highlights the need for tight coupling between strategy and IT as noted above. Powell and Dent-Micallef (1997) offered empirical support to this idea by measuring IT and various aspects of human resources (openness of culture, openness of communication, consensus, CEO commitment, flexibility, IT/strategy integration) to show that it is not IT alone, but IT used in support of these factors which produces performance advantages.

Second, research that simply looks for a direct IT-performance relationship in some sample of firms is confounded by the fact that the implementation of IT will likely have had a generic performance-enhancing effect for all organizations in the sample. Thus, between-firm differences may only be found when this across-firm effect is controlled for, and indeed the between firm effect may be significantly smaller and hence harder to detect. Teasing out these issues would obviously require a longitudinal research design in a sample where it is possible to control for industry level-effects. As an example of longitudinal research which does provides evidence of a positive impact on firm performance, Lind and Zmud (1995) demonstrate the utility of voice mail. In a sample including a manufacturer and its network of dealerships they established that a new voice mail system, a communications medium not previously available, did lead to a timely reaction to customer requests which led to an increase in performance as measured by an increase in dealership sales.

From a strategy perspective, another confounding factor may be that because of its assumed generic performance-enhancing effect, managers may also perceive correctly that they have to invest in IT or else suffer severe competitive penalties. For example, Huber (1990) argued that even in organizations that are highly politicized or power-driven, where one might think that some of the rational outcomes of IT (e.g., more accurate information or more timely decisions) may not be forthcoming, new IT will still be adopted because it is an

imperative in the organization's competitive environment. Empirical evidence provided by Ginsberg and Venkatraman (1992) supports this role of institutional context in terms of investment in new technologies.

Another factor to consider is that, as noted earlier, there may be several contingencies that produce the conflicting findings for the IT-performance relationship, much as researchers found for traditional structure-technology-performance relationships (Woodward, 1958). One contingency we believe merits consideration is whether or not IT has been employed primarily to foster efficiency, innovation, or both. We speculate that the use of IT to support innovative corporate practices will show a stronger between-firm performance effect as compared to an efficiency-based effect. For example, one human resource factor studied in conjunction with IT and firm performance by Powell and Dent-Micallef (1997) was flexibility – defined as a culture that embraces change and experimentation and welcomes opportunities to apply new IT developments.

Another important contingency factor may be the way IT is implemented. The role of organizational culture in implementing IT was noted earlier. One can also speculate that depending on the appropriateness of the IT system chosen (and firms do make mistakes), the time that it takes to implement a technology, the supporting training and other learning processes which facilitate the technology, and so on, the impact of IT will vary between organizations. In addition, not all IT applications are created alike. For example, an organization's ability to effectively train its workforce to use a given IT will vary widely with its complexity, something many firms have failed to consider. Thus there are many issues surrounding the implementation and use of IT in the organization that will affect the IT-performance linkage that need to be further studied.

4.3. The role of time in the application of IT

Figure 1 depicts a feedback loop linking organizational outcomes to IT to suggest that firms need to optimize their use of IT over time. Specifically, it has been suggested that time plays two crucial roles in the successful application of IT in the organization: time required for learning and time required for adaptation. For example, vonHipple (1998) suggests that investments in IT can result in two types of learning: first-order and second-order learning. First-order learning involves users determining how to use an IT to its fullest potential. Second-order learning involves modification of an IT over time to better match the organizational environment, which is often required for an innovation to be fully utilized (vonHipple, 1988). It is this first-order learning which represents the most basic role of time. Several authors have noted that organizations require time to learn how to effectively use any new communications related technology. For example, in an interorganizational context Kraut et al. (1999) suggest that any early negative effects of IT encountered might merely be transient given that many firms must face a learning curve in the use of new mediums before reaping their benefits.

vonHipple's (1998) definition of second-order learning highlights the more subtle issue of evolving contexts of use. Much of the literature in this area has assumed that the accommodation of new technology takes place initially during implementation (e.g., Leonard-Barton, 1988). Orlikowski et al. (1995) argues that this assumption is problematic given that

modern firms may change organizational forms frequently in response to changing circumstances. This will necessitate IT strategies that will accommodate the adaptation required for the technology to continue to be maximally useful. They argue that without a strategy to continually adapt IT to changing contexts, the technology will not reflect local conditions or communication norms and thus may be underutilized or inappropriately utilized. Norms for proper use may not be shared by all users and ambiguity or misaligned expectations may result. This view is shared by Yates, Orlikowski and Okamura (1999) who suggest that IT use is an evolving reality over time, not something set in stone when a technology is first implemented, so that organizational learning at both the individual and group level has to continually occur. Thus, the dynamics of electronic communication in a firm maybe different in the long run than the short run because new groups of users with somewhat different social realities are likely to emerge (DeSanctis & Monge, 1999). Orlikowski et al. (1995) offer a prescriptive discussion of how the organization can intervene with a set of activities they refer to as 'technology-use mediation' in order to facilitate the ongoing adaptation of IT to the contexts in which they is used.

4.4. Multilevel implications for the study of IT

A final research issue is the role of IT at different levels within the organization. As noted earlier, innovation and efficiency are the product of factors at multiple levels within the organization. Research examining this reality from an IT perspective will provide a compliment to the evolving contexts work begun by Orlikowski et al. (1995) and Yates et al. (1999). To date, at least one empirical paper has addressed this issue. Hinds and Kiesler (1995) examined the use of different communication mediums within a large corporation and found starkly different patterns of use between technical and administrative employees. Technical workers are often grouped in teams and arranged horizontally, making lateral communication, collaboration, and information sharing the dominant coordination mode. As opposed to technical work, administrative work has often been associated with hierarchical coordination where administrators communicate through a tall hierarchical chain of command. Hinds and Kiesler (1995) found that given their different position in the organizational hierarchy and their different communication needs, the two groups used communication mediums (telephone, electronic mail, voice mail) differently. Technical employees were found to have more lateral communication, and most lateral communication by both technical and administrative employees tended to be by telephone. When employees did choose to use a more advance communication medium, technical employees preferred electronic mail and administrators preferred voice mail. Moving forward, scholars must not only consider the different types of IT employed at different organizational levels, but the different roles that IT fulfill at different levels as well.

In conclusion, we are now only beginning to understand how advances in information systems and technologies will rewrite various portions of management theory. This paper has examine the many possible ways in which IT can increase efficiency, it has also analyzed the more hidden role that IT plays in affecting organizational innovation by increasing coordination and collaboration and creating opportunities for information synergies. We have also discussed several other important outcomes that are impacted by IT and provided a model

that we hope researchers will find useful as they theorize, measure, and investigate the effects of IT on organizational performance. We hope that the moderating effects of information efficiencies and synergies discussed in this paper will provide researchers with terms useful for framing the fundamental role of IT in the organization. As our review and assessment has suggested, such a process is just beginning.

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