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The Evolution of Research on Information Systems: A Fiftieth-Year Survey of the Literature in *Management Science*

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The development of the information systems (IS) literature in *Management Science* during the past 50 years reflects the inception, growth, and maturation of several different research streams. The five research streams we identify incorporate different definitions of the managerial problems that relate to IS, the alternate theoretical perspectives and different methodological paradigms to study them, and the levels of the organization at which their primary results impact managerial practice. The *decision support and design science* research stream studies the application of computers in decision support, control, and managerial decision making. The *value of information* research stream reflects relationships established based on economic analysis of information as a commodity in the management of the firm. The *human-computer systems design* research stream emphasizes the cognitive basis for effective systems design. The *IS organization and strategy* research stream focuses the level of analysis on the locus of value of the IS investment instead of on the perceptions of a system or its user. The *economics of information systems and technology* research stream emphasizes the application of theoretical perspectives and methods from analytical and empirical economics to managerial problems involving IS and information technologies (IT). Based on a discussion of these streams, we evaluate the IS literature's core contributions to theoretical and managerial knowledge, and make some predictions about the road that lies ahead for IS researchers.

Key words: decision support systems; economics of information systems; human-computer interface; information strategy; information systems; information technology; information systems organization; systems design; value of information

1. Introduction

Looking back on the development of the information systems (IS) and information technology (IT) literature in *Management Science* over the past 50 years reveals where the field started and how far it has come. During this time, we have seen a new academic field emerge around an area of innovation involving electronic computation, the storage, manipulation and transmission of digital data, the specification of computer-based algorithms to support decision making, and the creation of systems that link people, business processes, firms, industries, and markets.

Information systems research has a long history at *Management Science*. In 1967, Harry Stern started the "Information Systems in Management Science" column to provide a forum for discussion beyond just research papers (see also Summer 1967). In fact, the information systems area was included in the first departmental structure introduced at *Management Science* in 1969. It was represented in two departments: Information Systems (Applications) and Information Systems (Theory). Since IS and IT affect all management functions, research related to IS and IT has been published also by other departments of *Management Science*, and several of the earliest *Management Science* authors (e.g., Ackoff 1967) have written on information systems.

Since information affects organizations at many different levels in many different ways, IS research published in *Management Science* displays considerable diversity. Accordingly, we could organize this review of that body of work around the important managerial problems in the field; for example, how to get systems design right, how to manage interorganizational systems investment, how to evaluate IT for effective intraorganizational coordination, how to measure the value of IT-influenced changes, and how to assess the extent to which IT creates business value and productivity gains within the broad economy. Alternatively, we could analyze citations or gauge the critical mass of findings in different subareas of the IS field through "meta-analysis" of the literature (e.g., Culnan 1986, Melone 1990). We take a different approach, however. We examine the intellectual growth of the field via several different research streams that define the thrust of the theory and what managers have come to know as results.

We identify five research streams: decision support and design science, human-computer systems interaction, value of information, IS organization and strategy, and economics of IS and IT. These streams have developed over time to incorporate different definitions of the managerial problems that relate to IS and IT. We summarize these five streams in Table 1 in terms of their levels of analysis, associated theories, methodologies, and related disciplines.

2. Decision Support and Design Science

The genesis of the decision support and design science research stream lies in the earliest issues of *Management Science*. The application of the computing technology of the time, the late 1950s into the 1960s, was occurring in government and military applications as well as in business organizations. During that time, the discipline of management science was exploring the range of applications of computing power in production, planning, and other managerial settings (e.g. Vasyonyi 1965, Hsu 1968).

2.1. Early Decision Support Systems Research

The early vision of decision support systems (DSSs) (e.g., Coleman 1956, Jackson 1956, Kalaba and Juncosa 1956, Postley 1957, Hertz 1965, Raymond 1966, Ericson 1969, Kwerel 1968) is reflected in Beged-Dov (1967), who reasoned that employing IS provided a basis for more effective market evaluation, long-range planning, and production control. His predictions of the benefits of computer technologies were primarily founded upon the emergence of high-capacity random storage, falling data processing and telecommunications costs, the move from "applications" to systems, enhanced information retrieval capabilities, and the emergence of telephone-based hook-ups to "desk-size" computers with the power of medium-sized computers of the time.

Kriebel (1969) analyzed the design of information processing and DSS design. He employed team theory to illustrate the mutual dependency between the costs of acquired information and the decisions it supports. With a greater need for team members to be simultaneously involved in decision assessments, the predicted utilization factor level in time-sharing

Table 1 The Five Streams of IS Research, 1954–2003

Research stream	Level of analysis	Theories	Methodologies used	Related disciplines
Decision support and design science	System level, mostly in conjunction with human users or business processes, up to the level of a strategic business unit	Decision theory, network optimization, control theory	Mathematical programming, forecasting, simulation, expert systems	Computer science, operations research, economics, marketing, strategic management
Value of information	Individual decision makers, technologies in business process context, firm actions in market context	Information economics, real options theory, information sharing theory	Decision trees, analytical models, statistical analysis, mathematical programming, simulation	Economics, decision science, risk management
Human-computer systems design	User focused, involving both individuals and groups	Cognitive style, behavioral decision theory	Experiments, argumentation, simulation, system test-beds	Cognitive psychology, decision science, design science
IS organization and strategy	Spans levels: individuals, groups, business units, organizations, marketplace	Diffusion theory, media richness theory, resource-based view of the firm, transaction cost economics, task-technology fit, technology acceptance model	Models, case studies, field studies, experiments, surveys, cross-sectional and longitudinal designs, argumentation, blend of qualitative and quantitative methods	Organizational theory, strategic management, social psychology, cognitive psychology, economics
Economics of IS and IT	Spans levels: individual decision makers, business process/product/project, strategic business unit/firm, industry, market, economy	Theory of the firm, production economics, game theory, contract and incomplete contracts theory, network externalities	Analytical modeling, empirical analysis and econometrics, cross-sectional and longitudinal design, experiments, simulation	Economics, operations research, computer science, strategic management

systems needed to be aggressively managed to support decision making. MacCrimmon (1974) validated descriptive aspects of team theory related to decision heuristics and communication among team members in a management game. Moskowitz (1975) studied information and decision systems for production planning.

Subsequent work in this stream includes research on IS use in multicriteria optimization for workforce scheduling (Geoffrion et al. 1972), program storage in computers (Babad et al. 1976), regional blood management (Prastacos and Bradheim 1980), management of federal courts (Buchanan and Ferrell 1981), bid-based scheduling of job interviews (Lau and Kletke 1994), and expert system-based training for maritime navigation (Grabowski and Wallace 1993). Sharda et al. (1988) questioned whether the success of such systems could be effectively documented—whether value claims are based on empirical facts or mislaid perceptions. Limits to value of these systems are tied to constraints on design effectiveness, and to the task and process analysis work that must be done prior to constructing such systems.

2.2. DSS Design

Hansen et al. (1979) described computer-supported analysis to enhance DSS design. Messier and Hansen (1988) elicited rules for a knowledge base so a decision engine could predict firm bankruptcy from available data, while Piramuthu et al. (1998) built neural networks with better predictive capabilities. Kumar et al. (1993) used simulation to schedule facilities for hospital patients and found critical dependencies that arose with respect to organizational structure. Gaimon (1997) explored the application of decision technology to support knowledge workers.

This research emphasizes testing proposed and actual systems artifacts to establish their value in conceptual and technical design terms. Basu and Blanning (1998) used metagraphs to study DSS. Park et al. (2000) modeled telecommunication systems design to maximize network survivability with effective node clustering simulations. Garfinkel et al. (2002) provided algorithms for maintaining confidentiality in binary data sets, where threats to privacy exist (e.g., in medical data and voting records). Ram and Narasimhan (1994) constructed new approaches for providing concurrency controls in the allocation of database storage space for distributed and networked computing environments. Ramaswamy and Shell (1997) developed an "electronic bargaining table" to promote mutual gains in competitive negotiations. Intelligent agent technologies, as explored by Sikora and Shaw (1998) for printed circuit board manufacturing and enterprise subsystem coordination, remind us of the still-relevant call by Joyner and Tunstall (1970) for "computer-augmented organizational problem-solving."

2.3. Directions for Decision Support and Design Science Research

This research stream has been rapidly expanding with a range of new topics encouraged by technological advances, methodological innovations, and increased expectations for theory development and empirical analysis of the new artifacts. With the advent of telecommunication services and Internet-based commerce, research such as Kelly and Steinberg (2000) and Bapna et al. (2003) have analyzed the design of auction mechanisms, and Ba et al. (2001) have considered a market mechanism to design optimal strategies for investment in knowledge. We see this stream drawing closer to the value of information and economics of IS and IT streams.

3. Value of Information

Information value arises as the difference between a decision maker's payoff in the absence of information relative to what can be obtained in its presence. Comparisons are often made between *imperfect information*, which leaves the decision maker with a lower willingness-to-pay, and *perfect information*, to establish the maximum value that decision-relevant information makes possible.

3.1. Information, Managerial Flexibility, and Decision Making

Miller (1975) considered information presented sequentially to the user. Choices arise about which information to purchase first, whether to wait for more, and whether the price is justified. Miller pointed out that it may be possible for perfect information to be less valuable than imperfect information when the primary dependency is sequence of presentation. Ponssard (1975) identified dominance criteria for optimal strategic actions a decision maker should take with probabilistic outcomes. His results suggest that, with identical sampling costs, "efficient experiments" yield a more accurate reading of a conditional outcome. Ponssard (1976) assessed information value in competition, where states of the world and observed actions of managers or firms are correlated. This research suggests that trial marketing roll outs can convey information to competitors, but the experimenting firm can try the idea out first and benefit. Hoos (1971) examined the use of information systems in public planning, King and Cleland (1975) describe MIS design, and Parsons (1996) modeled information using information theory.

Merhofer (1997) showed why the value of perfect information is increasing in managerial flexibility—the addition of one potential managerial action while none is taken from the action set—when price and production quantity decisions are assessed. Hilton (1981) showed why managerial flexibility has no general monotonic relationship with information value, and that there is no general monotonic relationship for a decision maker's aversion to risk and the value of information. Building on Blackwell's (1953) characterization of "information fineness," Hilton identified accuracy and aggregation level as the critical determinants of information value.

Harris et al. (1982) analyzed settings in which divisional managers possess asymmetric information and different goals, while the firm's interest is in allocating resources for optimal production. They proposed an incentive-based transfer pricing scheme where divisions select transfer prices that are consistent with the revelation of full information about divisional productivity levels, but are not required to disclose them. McCardle (1985) and Mamer and McCardle (1987) used value of information-based thinking to optimize information acquisition for technology adoption under uncertainty with optimal stopping rules. Schwartz and Zozaya-Gorostiza (2003) applied real options to study commitment escalation and project investment, as information is gathered over time, recognizing the distinction between IT "investment" and IT "development" projects.

3.2. Information Sharing in Supply Chain Management

Interorganizational information sharing in procurement also has been of interest, and research has spanned supply chain and information management issues. Lee et al. (1997) explain the "bullwhip effect," the distortion of information to upstream suppliers as buyers' orders exhibit a greater variance than their sales. They point to problems with processing signals about market demand, rationing supplies to buyers when a supplier has limited production capacity and excess demand, effects of batched orders by buyers on suppliers' production choices, and fluctuating supply prices in the presence of spot-buying (Lee et al. 2000). Gavirneni et al. (1999), Cachon and Fisher (2000), Lee et al. (2000), and Li (2002) also analyzed demand information sharing and pricing issues in supply chains. Raghunathan (2000) modeled information sharing in a supply chain when demand is nonstationary. Gavirneni et al. (1999) modeled the value of information sharing between a buyer and a supplier in a two-level supply chain when there are capacity constraints on the supplies.

Cachon and Fisher (2000) analyzed the value of sharing information on both final demand in the market and firm inventory via interorganizational information systems (IOS), and estimated positive business value gains associated with full information disclosure, in spite of the potential risks of the business partner's exploitation of sensitive demand information. Lee et al. (2000) estimated the value of information sharing in a two-level supply chain involving retailers and upstream suppliers. Li (2002) analyzed information sharing when there is competition among buyers. He established a direct effect on firms that share information, an indirect effect on the competing firms, and the reasons why it may be appropriate to differentially share final consumer demand and operating cost data. Lee and Whang (2002) assessed information-related issues in e-procurement, and showed why secondary markets for excess inventories improve a firm's allocative efficiency in supply chain performance.

3.3. Directions in Value of Information Research

While research in this stream overlaps considerably with other functional departments of *Management Science*, with the increasing importance of IS and IT in how firms manage different functions, we expect convergence between this stream and the prescriptive research we discussed in the decision support and design science stream. We have seen IS researchers refine our managerial knowledge about the value of information as IT changes the availability and granularity of information (e.g., online, real-time data mining), the costs that decision makers face to retrieve information, the necessity for senior managers to better justify complex IT infrastructures and managerial processes to realize business value, and the sophistication of its use to create new strategic and revenue-generating opportunities for the firm while enhancing cost and risk management controls. We have seen the development of new theory related to the value of information in information-intensive operating environments. This will occur in online contexts where automated software agents have a nearly costless ability to monitor and process preprogrammed information structures through intelligent sampling approaches using decision-making algorithms that are tuned to evaluate different decision-making strategies and implementing different decisions in real-time.

We also expect to see new theories of electronic agency, which will rely on emerging technological capabilities to specify richer, algorithmically dynamic information endowments and the decision-making profiles of software agents. These software agents will process newly obtained information in an instant to arrive at assessments of the "electronic value of information" in more competitively complex and faster-paced decision-making environments than human decision makers are able to operate unassisted by computers. Financial markets and e-procurement offer good contexts for these observations. Personal investment management software agents can develop risk profiles that match our comfort level and available financial resources for different levels of risk in investing. Also, algorithmic e-auction bidding tools for last-minute bidding and other future technologies will permit "adaptive" solutions that change with the market or operating conditions to maximize firm value in procurement decisions.

4. Human-Computer Interaction

A crest of interest in research on DSS effectiveness occurred in the 1970s, while other researchers were assessing the more general impacts of the first 15 to 20 years of management science research. The focus was on the limited impact of management science practice, and the development of new approaches to improve the efficacy of DSS (Argyris 1971, Doktor and Hamilton 1973). Ackoff (1967, p. B147) worried about a core problem associated with IS: "management misinformation"; he claimed that users suffer "more from an over-abundance of irrelevant information than from a lack of relevant information." Ackoff (1971) argued for a "systems approach" to problem solving within "organizations as systems." He emphasized the need for a unified set of "systems concepts" to improve management's understanding of the design process. He also admonished management science practitioners and theorists that the widespread implementation of IS and DSS within the firm would change their lives, and sought to jump-start management scientists' thinking about how to overcome the resistance in executive's use of DSS-supplied information to run their businesses (see also Alavi and Henderson 1981, Lucas and Nielsen 1980).

4.1. Individual Traits, Psychological Types, and Cognitive Style

Other authors targeted *individual differences* and *psychological types* (Mason and Mitroff 1973, Myers-Briggs 1962), also referred to as *cognitive style* (Doktor and Hamilton 1973, Mitroff et al. 1974, Huber 1983). Cognitive style and individual traits research emphasized polar opposites for the purposes of exposition, while recognizing that people exhibit a continuum of traits: the *global* or the *heuristic cognitive style* versus the *analytic* or *systematic cognitive style* (Dickson et al. 1977, Bariff and Lusk 1977). Zmud (1978, p. 1088) characterized the contrast: "[T]hose classified as analytics tend to approach problem solving with a formal, algorithmic search for causal relationship in data while those classified as heuristics employ a common sense, trial and error approach to problem solving."

The Minnesota Experiments. These studies (Chervany and Dickson 1978) examined systems design issues and the role of adapting them for human users to maximize their effectiveness. Chervany and Dickson (1974) used an experimental research design involving potential "information overload" to determine the effectiveness of decision makers with the use of raw data in a management game simulation. They found that summarized data enabled decision makers to understand key management problems and develop consistent solutions. Similar to Hilton (1981), Chervany and Dickson recognized that summarized information does not offer the same basis for decision making in the absence of information of finer granularity. Related research argues for case, field, and lab studies, and experiments to obtain a more refined understanding of decision *effectiveness* when the *decision maker*, the decision *environment*, and the *characteristics* of the IS that *support* the decision maker all vary. Dickson et al. (1977, p. 913) conducted nine computer simulation experimental games in production management, and found that participants' decision making "was affected by the IS structure and attributes of individual decision makers."

A year later, in 1978, *Management Science* published two point-counterpoint articles on "The Minnesota Experiments." Zmud (1978), questioning the broad conclusions, argued that the validity of the research instrument used in Dickson et al. (1977) to determine the impacts of analytic/systematic/thinking versus heuristic/global/feeling approach to DSS-supplied information was unproven in view of a number of inherent weaknesses. He suggested the appropriate conclusion to draw about cognitive style from "The Minnesota Experiments" was more limited, pertaining only "to a decision maker's choice of a planned or spontaneous solution strategy" (Zmud 1978, p. 1090). Other papers examined cognitive processes, psychological traits, and user involvement in systems design (e.g., Boland 1978). Bariff and Lusk (1977) and Lusk and Kersnick (1979) emphasized selecting (not creating for the specific purposes of the research) validated and reliable psychological test instruments to support learning about cognitive style and "implementation apprehension" as they relate to the outcomes of systems analysis work and IS-generated report formats on user task performance.

Zmud's (1977, 1979) and Lusk and Kersnick's (1979) critiques of "The Minnesota Experiments" made clear the growing sensitivity to research design quality that would support new contributions to knowledge. The latter paper emphasized the importance of strong research design, both in the construction of the experimental tasks and methods and the controls put in place to tease out useful results. Huber (1983) subsequently challenged the emphasis on individual traits and the psychological determinants of man-machine performance. He offered two conclusions from a "meta-analysis" of the research literature (p. 567): (1) "The ... literature on cognitive styles is an unsatisfactory basis for deriving operational guidelines for MIS and DSS designs"; and (2) "[f]urther cognitive style research is unlikely to lead to operational guidelines for MIS and DSS designs." With Huber, we see indications that DSSs would need to be flexible in terms of the different kinds of people, decisions, and decision contexts they support.

Robey (1983, p. 580) responded with a different interpretation of the research results and argued: "[T]he cognitive styles research, however messy it has been, has provided much of the rationale for a flexible DSS." With these words, we see an early glimpse of the future of IS research and practice, including "technology acceptance" (Davis et al. 1989) and "task-technology-fit" theory (Goodhue 1995), and prototyping and rapid/joint application design. Ramaprasad (1987, p. 139) pointed out that prior research failed "to address the fundamental reason for the failure of cognitive style research to provide specific, operational guidelines for MIS and design. The appropriate response [is] to focus on cognitive processes."

4.2. Group Decision Support

Later research examined systems support for individual and group decisions. They include situational factors when table-based data better support decision making than graphical data (Remus 1984), the use of data models and intuition in business forecasting (Blattberg and Hoch 1990), and diagnostic reasoning with DSS (Bouwman 1983). DeSanctis and Gallupe (1987) provided frameworks for conceptualizing how to design and apply group DSS (GDSS) and electronic meeting systems (EMS) to enhance the effectiveness in group meetings. Their call for research resulted in a 1991 special issue of *Management Science*. Nunamaker et al. (1991) showed how EMS is effective for brainstorming and generation of new ideas in group interactions. They emphasized the capabilities of EMS to support parallel communication, assisted group memory, and the anonymity of the respondents (thereby masking power and status relationships among the participants). They further noted that EMS technology tends to have its most beneficial effects as group size increases, by controlling process losses and enhancing process gains.

Poole et al. (1991) theorized about what happens when GDSS members experience conflicts. They characterized seven different kinds of impacts on conflict management that may arise in computer-supported meetings: exploration of alternatives, clarification of roles and procedures, more use of voting, de-emphasis of personal relations, equalization of participation, reliance on written media, and greater expression of affect. Rao and Jarvenpaa (1991) proposed additional contingency models for GDSS-related research, based on assumptions about what GDSS can provide. Anson and Bostrom (1995) examined facilator effects on GDSS-supported meeting outcomes.

4.3. Directions in Human-Computer Systems Design Research

We predict a resurgence in interest in this research stream. Why? First, the ongoing interest in human-computer interaction and man-machine systems design is likely to expand as the capabilities of IT continue to expand. Today, we have a new generation of handheld devices and PDAs, fixed-point and mobile wireless technologies and increasingly ubiquitous network and Internet connectivity, automated software agents and decision "butlers," and embedded technologies in business processes and products. But all these technological aids present the human user with limits to value in actual use, so that the potential value is rarely realized by the users, decision makers, and organizations that invest in them. Second, the business value of these technologies is as much a matter of the design of the business processes and organizational structures in which they are used, as are the cognitive qualities and information processing capabilities of their users.

Emphasizing these aspects at the expense of other individual-level man-machine issues probably is not appropriate. We expect to see a more balanced research agenda, extending our knowledge of human cognition in man-machine environments, and enhancing our ability to design effective technological means to deal with current problems: fraud on the Internet, effective use of IT-based collaborative tools, information overload, and computer agent-based negotiations. We expect more integration between research approaches that involve theories from psychology and cognitive science, and others (e.g., organizational theory or economic theory). The reasons lie in the increasing openness of academic research to interdisciplinary theorizing related to human-computer interaction, and the real need for richer explanations to make IT work well in complex applied settings.

5. IS Organization and Strategy

The earliest indications of the emergence of the IS organization and strategy research stream came as IS researchers began to recognize the importance of conducting IS research at other levels of analysis, including the system, business process, strategic business unit, and organizational level.

5.1. User Involvement and Satisfaction in Systems Development and Use

IS Use and User Satisfaction. Swanson (1974) and Lucas (1975) reported results of early field study research. Swanson (1974, p. 179) explored the importance of the appreciation of IS by managers. He argued for a link between the extent of *a priori involvement* by a user in the systems analysis and design process and her subsequent appreciation and use of the system to inform her managerial decision. Lucas (1975) found that the decision style of the user had impacts on both IS use and subsequent managerial analysis and actions, and their evaluation in terms of performance outcomes. He evaluated this perspective for salesforce performance and sales IS use for a large clothing manufacturer. His results are some of the earliest indications of the complexity of relationship between IS use and performance and the range of variables that make use of a system an imprecise predictor of user performance and system value.

Bailey and Pearson (1983) were first to validate a multifactor instrument to analyze user satisfaction. It involved 39 empirically tested factors, and was based on a definition of *user satisfaction* stated in terms of the "sum of the user's weighted reactions to a set of factors" (p. 531). Melone (1990) provided a theoretical and interpretative assessment of the "user satisfaction" construct. Her recognition of the lack of a clearly articulated theory tying user satisfaction to system effectiveness led other researchers to understand the business value of IT through other means of measuring the outcomes.

User-Developer Communication Patterns. Debrabander and Edstrom (1977) offered another assessment of the direction in which this research stream would develop. They studied the communication and interaction patterns of IS specialists and users to determine what led to success in development and use of systems, and argued that the central problem in their communication is that they bring different perspectives to their interactions. Daff and Lengel (1986) related information requirements and media richness to structural design. Huber (1982) identified other aspects of communication relative to IS performance involving *message effects*: *message routing* to targeted users, *message summarizing* to make information sent to users more easily understood, *message delays* reflecting the sender's priorities, and *message modification*, including sender-to-receiver message distortion. Later, Sproull and Kiesler (1986) examined the consequences of message transmission by e-mail within organizations, recognizing a reduction in social context and concomitant changes in behavior, including self-absorption, status equalization, and changes in behavioral inhibitions in communication.

Robey and Farrow (1982) situated their analysis of effective user involvement in systems development in the Lewin-Schein conceptualization of three stages of behavioral change in the organization: unfreezing, moving and refreezing. However, the authors recognized the need to find a modeling representation that further captured "the dynamics within the change process itself" (Robey and Farrow 1982, p. 74). They represented user participation in a process of conflict resolution related to the design of a system. Debrabander and Thiers (1984, p. 140) further examined the effectiveness of communications between IS users and developers to understand the "crucial intervening factor" of "effective communication" between developers and users. The authors emphasized that agreement should be reached by both sides about the systems artifact. Doll and Torkzadeh (1989) focused on "end-user control" and noted that user involvement does not always lead to enhanced satisfaction.

The "Theory of Reasoned Action." Other researchers argued that user involvement and participation have not been adequately understood. Hartwick and Barki (1994, p. 440) differentiated the constructs of *user participation* and *user involvement*, with "participation leading to involvement, and involvement mediating the relationship between participation and system use." Their analysis was conducted using Fishbein and Azjen's (1975) *theory of reasoned action* (TRA), to argue that *attitudes toward behavior* (e.g., a person's use of a system) tend to have a more important bearing on the prediction of a user's behavior with a system than *attitudes toward an object* (e.g., the system itself). They assert that "overall responsibility is the most important antecedent of user involvement and attitude toward the system" (Hartwick and Barki 1994, p. 457). Kirsch et al. (2002) examined four kinds of control of IS projects when there is client-side leadership: *behavior control*, *outcome control*, *clan control* and *self control*. They advocated including behavioral measures for the project manager and outcome measures for the IS project as predictors of the different project control modes, in the presence of a moderating effect involving the client's understanding of the IS development process.

5.2. The Technology Acceptance Model and Diffusion of Innovations

The user involvement work led to the exploration of other aspects of systems design and use, and user satisfaction. Davis et al. (1989) provided an alternative perspective to TRA. Their technology acceptance model (TAM) incorporated *perceived usefulness* and *ease of use* of a system, to form a basis for predicting the degree to which user acceptance should occur. Szajna (1996) extended TAM. Prior to implementation, perceived usefulness and perceived ease of use are drivers of a user's intention to use a system. After implementation, ease of use conditions usefulness more than a person's intentions to use the system. Venkatesh and Davis (2000) proposed a new model, "TAM 2," that includes the original predictors of perceived usefulness, Szajna's additions, and subjective norm, job relevance, output quality, voluntariness of use, user experience, and result demonstrability.

They evaluated the new theory with four longitudinal studies. The results show consistency across organizations and over time periods.

Another important topic is the *diffusion of technological innovations*. Zmud (1982) recognized the inconsistency in the findings about *centralization* and *formalization* in studies of organizational innovations with administrative processes and technology. The former indicates the preferred origin of the strategic motivation for technological innovation, as well as the desired locus for innovation-related activities. The latter refers to the process by which efforts to create technological innovations are undertaken. A formalized innovation process contrasts with an informal process: the latter can yield innovation by surprise, whether the firm wants it or not.

A decade later, Cooper and Zmud (1990) developed a new theory to explain the success of the organizational adoption and infusion of new technology in terms of the compatibility of the *technology's characteristics* with the *characteristics of the task*, and the *complexity of the technology* relative to the *task complexity* that necessitates it. Ginzberg (1981) had earlier examined reasons for MIS implementation failure. Fichman and Kemerer (1997) studied the assimilation of software process innovations. The main results were derived from an empirical study of material requirements planning (MRP) system adoption for U.S. manufacturing firms. Organizational adoption of MRP was inhibited by more complex production planning and control tasks, and by whether an organization's planning and control tasks are in synch with MRP capabilities. This work presaged development of other perspectives that focused on contextually-rational and political explanations about adoption of IT. Nilakanta and Scamell (1990), showed that the diffusion of tools for data base requirements analysis and logical design is influenced by the multiple information sources used by decision makers. Swanson (1994) further structured our understanding of IS innovation types and their associated diffusion dynamics: task-related innovations, administrative innovations, and infrastructure technologies. Goodhue (1995) proposed the *task-technology fit model* for understanding IS user evaluations to extend Cooper and Zmud's (1990) theory. Task-technology fit is "the extent that individual technology functionality matches task requirements and individual abilities" Goodhue (1995, p. 1829). He hypothesized that good fit should lead to higher performance of the user.

5.3. IS, Strategic Planning, and the Organization

Ein-dor and Segev (1978) analyzed the importance of the organization's strategy for a system, its planning mode (e.g., bottom-up, evolutionary, etc.), the support of IS in the organization structure, whether the system is an innovation, and its overall purpose. They also point to how a system creates value through direct and indirect benefits, the impact of human resources competencies, issues related to construction, and functional sophistication of a system. Sethi and King (1994) studied how IT creates external competitive advantage, and Malone et al. (1999) illustrated how firms can use IT-based tools internally to identify value-bearing business process redesign and reinvention approaches. Mendelson (2000) studied how organizational architecture affects the success of IT firms. Zaheer and Venkatraman (1994) conducted an empirical study to identify the determinants of electronic integration. Marsden and Tung (1999) examined the use of information systems technology to develop tests on asymmetric information and insider trading. Moore (1979) studied the effects of alternative information structures in a decomposed organization and Markus and Robey (1988) studied the structure of information technology and organizational change.

This sensitivity to organizational strategy, systems planning, and IT value prompted follow-up work. Apte and Mason (1995) analyzed effective global disaggregation of IS services for outsourcing and in-house development, and Zaheer and Zaheer (1997) explained how IT-driven *organizational alertness* and *strategic responsiveness* affect the capabilities of international firms. Faraj and Sproull (2000) explored how to effectively coordinate technical and process knowledge and expertise in software development teams. This stream of research also has called for new methods. For example, Bharadwaj et al. 1999 measured impacts of IT on stock valuation and Keeney (1999) assessed the potential value of e-commerce activities.

5.4. Research Directions in IS Organization and Strategy Research

In addition to the works that have been published in *Management Science* and are reviewed here, other research in this stream has been published in other specialized IS journals in the past two decades. We expect this research stream to continue to make important contributions to managerial knowledge in IS.

This stream will seek to formulate stronger theoretical bases for the contexts in which it offers explanatory and interpretive models of individual, group, and organizational behavior associated with the management of IS. We also expect that there will continue to be efforts made to adopt more sophisticated quantitative tools for the analysis of applied problems, and more instances of the use of various theoretical perspectives, blending the work here with the economics of IS and IT stream.

6. Economics of IS and IT

Management Science has been instrumental in nurturing research on the economics of IS and IT, which has provided some of the most important insights into the impact of IT in recent years. This research stream spans IT-based coordination for organizations, markets, and industries; software engineering economics and IT value; market microstructure; network externalities and the adoption of network technologies; and e-commerce and information goods.

The earliest works associated with this research stream occurred in the 1960s. Gold (1964) assessed the effects of technological innovations for the first 40 years of the 20th century for a variety of American manufacturing industries. He emphasized the economy-level adjustment and impacts of technological changes in production on unit costs, cost proportions, product prices, output levels. He hypothesized that increasingly technological production capabilities supported production of more complex goods with higher costs, lessening unit cost and cost proportion reductions. Zani (1970) considered impacts of real-time systems relative to batch processing systems and found no empirical evidence for operational or competitive advantage. He suggested that real-time systems advantages would arise only from integrating them into the management processes of firms. Ballou and Pazer (1985) and Ballou et al. (1998) recognized the multi-input, multi-output characteristics of information systems.

6.1. Productivity and the Business Value of IT

Kriebel and Raviv (1980, p. 299) analyzed computer systems performance through the microeconomic production process that "relates inputs used to the outputs produced, and determines the set of feasible output combinations" for the system. They used mathematical programming, a precursor to the later data envelopment analysis (DEA) applications, to estimate efficiency and support effective managerial decisions about system investments and expectations for the highest feasible systems outputs. Chismar and Kriebel (1982) extended the model to settings where only subsets of the inputs are required, to identify bottlenecks in the production of computer services.

IT Investments, Firm Size, Productivity, and Value. Subsequent studies considered the impacts of IS in terms of productivity, business value, and quality, as well as in terms of their impacts on industrial organization. Brynjolfsson et al. (1994) asked the question: "Does IT lead to smaller firms?" Similar to Gold (1964), they hypothesized that production in the U.S. economy was shifting, only to smaller firms in the presence of technological change. The authors tested hypotheses about the effects of firm size, production costs, and coordination costs. IT was associated with smaller firm sizes, based on multiple models and different specifications of firm size. Also, rapidly declining prices for IT inputs set up exogenous forces for growth in IT investment, which also created favorable conditions for a shift to smaller firms. Kelley (1994) also contributed to our knowledge of IT-driven productivity gains, with an empirical study of U.S. machining and manufacturing process firms. She hypothesized about the influence of technical, economic, and organizational factors that mediated manufacturing productivity, and were moderated by firm size. She estimated the benefits associated with programmable, numerically-controlled machining, especially in terms of the labor effort required to set up jobs that required fine tolerances in their machining.

Srinivasan et al. (1994) also studied manufacturing firms in the United States. Their focus was on the impacts and business value of electronic data interchange (EDI) technology on just-in-time (JIT) product shipments. They found that vertical integration which EDI permits in a firm's supply chain activities enhances JIT product creation and the performance of an organization's logistics and distribution. A significant result is the empirical regularity that suppliers with a larger variety of supply parts tend to experience a larger number of shipping discrepancies, and higher operating costs as a result.

The Productivity Paradox. Although the studies we have cited reported positive findings on the productivity impacts and business value of IT, other empirical research on IT value created more mixed impressions. Brynjolfsson and Hitt (1996) posed the question "Paradox lost?" regarding their positive firm-level evidence on the returns to IS investments in American industry. Estimating annual production functions for 367 large firms in a variety of industries, they reported a statistically significant correlation between computer capital stock and firm output, with an estimated net marginal product of 67% per year. Adjusting the net marginal product for the shorter useful lifetime of computer capital than the firms' stock of plants and equipment, their result was one-third less at 48%, but still quite high.

Gurbaxani et al. (1997) reported on an industry survey of corporate budget practices that attempted to distinguish between personnel expenditures and hardware expenditures. They found no scale size effects for information services production, at both levels of analysis, across both the manufacturing and services industries. Application development was positively associated with additional IS staff, but negatively associated with hardware. This suggests the labor-intensiveness of applications development and maintenance, an explanation for a different budget share to go to personnel.

IT Substitution and International Productivity Estimates. Dewan and his coauthors took this inquiry in two other directions. Dewan and Min (1997) measured how much IT investments were substituting for other factors of production. Their data set involved 1,131 firms in the manufacturing and services industries in the United States. Their results confirmed the general estimate of gross and net marginal products from IT investments of Brynjolfsson and Hitt (1996), and suggested that there was some positive substitution occurring between IT capital and "ordinary capital" and labor. Dewan and Min (1997) found evidence for greater excess returns to IT and a higher observed level of substitution in the manufacturing sector compared to the services sector. Dewan and Kraemer (2000) examined differences in IT investments and productivity for developed and developing countries and found evidence that returns for IT capital were positive and significant in the former. Developing countries tended to have substantial returns from non-IT capital, but no significant positive returns from IT capital spending.

Process Performance, Customer Satisfaction, and Systems Use Effects. Recent work on IT value emphasizes other aspects of organizational performance. Mukhopadhyay et al. (1997) studied optical character recognition and barcode sorting technologies in United States Postal System mail facilities over three years. Mail sorting output performance and quality was enhanced by the application of barcoding technology. Krishnan et al. (1999) examined IT as a potential driver of customer satisfaction in financial services. They found that the primary driver of perceived quality of service has to do with a bank's product offering, but that IT can be a useful lever to create high levels of satisfaction in the other measures. Devaraj and Kohli (2003), in a study of healthcare firms' investments in IT, found that for business value to accrue, it was essential for a sufficient level of actual use of the systems and applications to have occurred.

6.2. Software Engineering Economics

Software engineering economics reflects theoretical and methodological advances for the practice of management science in real-world software development. The work in this area during the 1980s and early 1990s focused on software cost estimation and the assessment of the productive efficiency of software projects. A representative example is Cusumano and Kemerer's (1990) study of American and Japanese software practices. The authors reported that both countries' software projects were of approximately equal size, complexity and sophistication, and that they used similar tools. However Japanese software projects evidenced a greater reliance on software testing professionals and higher code reuse, while both seemed to show equal use of development support tools. No evidence was found to support any performance differences for productivity and quality.

Software Development Productivity. Data envelopment analysis (DEA) (Charnes et al. 1981) and its extensions to handle scale economies (Banker et al. 1984) and hypothesis testing about the estimated production frontiers (Banker 1993) offer measurement innovations for software project assessment. Researchers have used DEA to model software development as an input-output production correspondence. Banker et al. (1991) used stochastic DEA, which permits assessment of random errors and mismeasurement, to evaluate software maintenance projects. They explored whether labor effort for analysis and design is separable from coding and testing, how structured analysis and design impacts productivity, and whether high productivity can be sustained for higher-quality software products and larger projects. Banker and Slaughter (1997) studied enhancement projects in software application maintenance for returns to scale based on DEA efficiency ratings. They used a statistical hypothesis testing technique for DEA (Banker 1993) to reject a null hypothesis of constant returns to scale in software maintenance, and suggested why variable returns for different project scale sizes are observed.

Maxwell et al. (1999) examined the efficacy of developing firm-specific software cost estimation models, relative to an industry-wide model for productivity estimation, using projects from the European Space Agency. They found that benefits could be derived from the firm-specific models for cost estimation, but that there would be insufficient resources available at many firms to build them. Banker et al. (1998) blended an economic and psychological view of software development maintenance to specify a theoretical framework for the effects of software complexity, code generation, and packaged software use on maintenance project performance.

Software Quality, Capability Maturity, and Software Contracts. Other studies emphasize the management of software quality. Harter et al. (2000) conducted an empirical study of software projects that shows firm use of the Software Engineering Institute's Capability Maturity Model (CMM) results in software applications of higher quality produced at a higher cost. Krishnan et al. (2000) investigated quality conformance and productivity. Quality was predicted by software size, development personnel capabilities, front-end investments, software process differences, and CMM methods conformance. Also, Harter and Slaughter (2003) found that higher levels of software process maturity yield higher product quality and reduced infrastructure activity costs, but the benefits obtained from CMM methods were empirically justified.

Whang (1992) investigated software contracts in terms of the definition of the software product, the related intellectual property rights, and the payment structure and contingencies. He also developed a game-theoretic model to show how the divergent interests of the purchaser of the system and the developer can be reconciled through a contracting mechanism that specifies the damages that must be paid by the developer according to a set of pre-specified performance contingencies. Wang et al. (1997) evaluated contract structures for customer software development that related to both internal development and software outsourcing.

6.3. IT Planning, Knowledge Workers, and IS Human Capital

This stream also includes research on IS planning. Berg (1975) suggested a planning perspective that incorporates ideas from international trade theory. He thought that comparative advantage-based thinking would assist in the adoption of new IS and technological innovations among universities. Hann and Weber (1996) explained why IS planning practices differ across organizations. They characterized the differences in terms of the uncertainty that senior managers and their employees may face, the extent to which a relational dependency arises between different stakeholders, the agency costs that are involved in monitoring compliance, and the monitoring activities that go into the development of a plan as a "contract."

Labor costs associated with IS professionals represent a significant component of most corporate IS budgets (Brynjolfsson and Hitt 1996, Gurbaxani et al. 1997). Ang et al. (2002) discussed the basis for the compensation of IS professionals in terms of their human capital and other institutional determinants. They estimated a model with human capital variables for education and IT experience, gender, and job. Human capital—education level and IS experience—explained the variation in observed levels of compensation among IT professionals in Singapore. Institutional differences did not explain the compensation differences in isolation from other explanatory variables. Anderson et al. (2000) studied executive compensation in the IT industry. They showed that the compensation shares of both bonuses and stock options are increasing in executive performance, and that these compensation tools lead to higher performance by the firm.

6.4. Economics of Technology Diffusion

Another major topic of research represented in the IS literature is adoption and diffusion of technological innovations (Norton and Bass 1987). Randles (1983) modeled the diffusion of handheld calculators and time-sharing computer terminals in engineering environments in the electronics industry, and then estimated a logistic function to analyze a diffusion model in differential equation form.

In the 1980s, IS researchers began to use network externality theory for the analysis of technology adoption, pricing, and use. Westland (1992) modeled the optimal short-run pricing of IS services to obtain efficient schemes for transfer pricing and IT service levels in the presence of positive demand and negative congestion externalities. Brynjolfsson and Kemerer (1996) estimated the hedonic value of individual applications that comprise software suites, and found that the linkages between different products elicit higher levels of consumers' willingness-to-pay. Xie and Sirbu (1995) characterized optimal pricing behavior for network products when an incumbent firm and a new entrant compete. They argued that the new entrant should choose compatibility when the incumbent's installed base is large and there are network externalities, and the incumbent should prefer to support the development of a common standard, which the new entrant could also adopt. Conner and Rumelt (1991) found that software piracy has a counterintuitive positive impact, since it increases the installed base of the software in the market, leading to larger network externalities, which, in turn, may lead to greater sales demand. Other work in this stream of research includes Jensen (1998), Oliva (1991), and von Hippel (1994).

Network externality theory also has been used to interpret adoption for interorganizational IS. Riggins et al. (1994) noted a "stalling" problem due to negative competitive externalities that suppliers face as a buyer's EDI network grows, leading to downward pressure on suppliers' prices. They call for a subsidy to neutralize supplier reluctance to adopt. Wang and Seidmann (1995) distinguished between the positive externalities of a large installed base of suppliers for a buyer, and the negative externalities of increasing competition for participating suppliers. They observe that a subsidy policy would never confer sufficient benefits to push suppliers beyond partial adoption.

Loch and Huberman (1999) proposed a *punctuated-equilibrium model of technology diffusion*. The authors noted that better technologies are not always adopted in the marketplace due to the existence of two different stable equilibria. One outcome involves the old IT as the standard, with the associated network externalities; the second involves the new IT as the standard, which is reached in the presence of a sudden shift in consumer preferences, accompanied by consumers' willingness-to-pay and switching costs.

6.5. Coordination Mechanisms and the Ownership of IT Assets

Malone (1987) and Malone et al. (1987) contributed new theoretical perspectives on intraorganizational and interorganizational coordination that are built on transaction cost theory. IT shifts the boundaries of the firm and changes the risks it faces in procurement, production, and transaction making. The authors proposed new IT-driven coordination structures that are consistent with improving organizational performance. Brynjolfsson (1994) applied the theory of incomplete contracts (e.g., Grossman and Hart 1986, Hart and Moore 1990) to explore the conditions under which the ownership of information assets and IT makes sense for the organization, why firm boundaries may shift in the presence of business processes that involve more or less contractible elements, and how decisions about the location and use of coordination information affects the distribution of ownership of productive assets across firm boundaries. Nault (1998) modeled informational asymmetries in IT investments from the perspective of "central" or corporate-level managers versus "local" managers in divisional and field operations. The author's model does not favor centralized over decentralized decision-making control; instead, it sheds light on the conditions under which one coordination structure is preferred.

Related problems for coordination in market settings were treated by Nault and Tyagi (2001), who constructed incentive mechanisms for the coordination of interorganizational production activities when the business partners benefit from network externalities through IT alignment and form horizontal strategic alliances. Anand and Mendelson (1997) compared centralized, decentralized, and distributed coordination structures for firms that face stochastic demand in multiple markets, in both upstream and downstream operations. The authors characterized decision-making problems for production with team theory. Participants in procurement and sales operations are tied together by their joint goal of maximizing firm profits. Finally, Lee et al. (2000) investigated channel coordination in supply chain management in the personal computer industry and showed how manufacturers can work to optimize price protection credits as rebates to retailers who are stuck with unsold inventories of rapidly depreciating PCs, while the next generation versions are set to ship.

6.6. IT, Financial Markets and Internet-Based Mercantile Exchange

The design of telecommunications markets has long been of interest (Bard and Bejjani 1991) but the impacts of IT in financial markets and mercantile exchange have received considerable attention during the last 10 years in IS research.

IT Impacts in the Financial Markets. IT changes the operating environment for market traders and dealer intermediaries. Clemons and Weber (1997) developed a market simulation based on the trading mechanisms of the London Stock Exchange, to test the effects of dealer quotes on price-quantity combinations of a Stock Exchange customers' order flow. The authors provided simulation evidence that an effective signaling mechanism is necessary to balance the needs of traders (including liquidity traders and informed traders) and dealers, and communicate information about the time-sensitive nature of the trade, which involves self-revelation by a *trader* of the urgency of his *trade*. Marsden and Tung (1999) examined how IT can be used to test for insider trading and the exploitation of asymmetric information in a controlled laboratory environment. They found that better informed traders tended to earn high profits in their simulations. But the imposition of a penalty for the detection of use of insider information made the profit levels indistinguishable. They also showed that shared information is transmitted very rapidly, leading to equal profitability outcomes for informed and uninformed traders.

Other research contributes insights on how IT enables better-informed traders to profitably participate in financial market trading activities. Dewan and Mendelson (1998, p. 596) modeled the process by which traders "close the gap between value and price due to new information." They emphasized the ability of a trader, who recognizes a difference between the market value of a security and the value the firm's IS indicates, to leverage knowledge of the difference by buying or selling a security, as appropriate. IT investments supporting trading activities in competitive markets have strategic benefits, but they are derived from operating cost advantages, not information-driven trading leverage. Dewan and Mendelson (2001) deal with IT investment with an intermediary-dealer or market maker. The authors found that investment levels will be sustained for a larger number of traders, but eventually will decline when liquidity is exogenously determined, because profitability is less sensitive to the use of information.

Internet-Based Market Mechanisms for Mercantile Exchange. IT creates opportunities for enhancing mercantile exchange in nonfinancial markets that result in new transaction-making environments. Kelly and Steinberg (2000) discussed the design of a combinatorial auction for the assignment of the electromagnetic spectrum for public mobile telecommunications services. More recently, Bapna et al. (2003) studied bidder behavior and multiunit auction design on the Internet. They modeled the optimal bid increment based on the revenue earned by the auction operator, and then performed empirical analysis of real-world auctions to show the behaviors of three kinds of auction participants in the presence of different bid increments.

Ba et al. (2001) view the value of knowledge as a public good in an organization. They propose a knowledge-sharing mechanism in an internal market in which traders have incentives to reveal true valuations for the components of knowledge goods in a bundle. Any market mechanism that does not permit trading knowledge bundles yields underinvestment in knowledge by the firm. Lee and Whang (2002) considered effects of secondary markets for reselling excess inventory in supply chains. The problem arises with the failure to forecast demand well for short-life-cycle products. Their results show that even though the presence of a secondary market for reselling excess inventory leads to improved supply chain performance, it is only possible to specify whether a manufacturer's sales will increase or decrease when certain conditions are present (i.e., larger reseller purchases from the manufacturer cause secondary market prices to fall). So resellers will tend to carry more inventory and resell less.

6.7. Economics, IS, and Electronic Commerce

The application of theory, modeling, and empirical methods from economics has been a natural direction for research on e-commerce on the Internet, including consumer Internet search, price dispersion, and information goods. Bakos (1997) noted the transformational impact of e-intermediation services that link buyers and sellers in e-markets, reducing buyer search cost (see Harrington 2001 for a critique). Predictions about seller profits and buyer surplus are complex when buyer tastes are heterogeneous, though. They must search for matching product descriptions and low prices. E-intermediation can improve market efficiency through lower prices and seller profits. However, buyers will tend to overinvest, while sellers, recognizing negative impacts on profit, will tend to underinvest.

This literature also explores the behavior of prices for goods and services sold on the Internet. Brynjolfsson and Smith (2000) found evidence of 9% to 16% lower prices and price dispersion for books and CDs during 1998 and 1999. They noted smaller incremental price adjustments among Internet retailers than traditional sellers, whose menu costs for posted-price changes are higher. Clemons et al. (2002) studied online travel agents, and found that airline ticket prices varied by as much as 18% across different online travel agents, due to differences in product specifications, despite identical customer requests.

Bakos and Brynjolfsson (1999) analyzed whether bundling information goods, which have low marginal production costs, enables a seller to better predict a consumers' valuation than when the information goods are sold separately. This predictive value of bundling may lead to higher profits for the seller and more profit per information good included in the bundle. Sellers of bundled information goods may also exploit such information on different consumer segments to set prices and identify appropriate information goods to bundle up.

Jain and Kannan (2002) found that variations in the expertise of consumers and the extent to which they value the information goods delivered via the servers will have an important influence on how the firm selects information goods pricing strategy. Dewan et al. (2000) analyzed Internet service providers' (ISPs) and information goods content providers' choices about how to distribute and price goods and services. Different equilibrium outcomes will occur, depending on average value of proprietary content to consumers and the number and cost structure of competing ISPs.

The Internet also has transformed the delivery channels for corporate and consumer financial services (Balasubramanian et al. 2003). Hitt and Frei (2002) found that PC banking customers tend to be more profitable, even after they controlled for differences in the customers' demographic profiles and the lifetime of customers' accounts, and distinguished between short-term and long-term relationship effects.

6.8. Research Directions for the Economics of IS and IT

We see several different directions for IS research in this area. There are new perspectives associated with this research stream that increase the strength of the theory and enhance managerial knowledge. The research on software engineering economics in *Management Science* is an exemplar of the increasing sophistication of insights that are available for effective management of software projects and software quality. We expect this trend to continue and include other managerial issues such as knowledge management, IS development and infrastructure outsourcing, Internet-access pricing, design of IT-based market mechanisms, and intellectual property rights and information goods.

Future research in this stream will deal increasingly with problems that are viewed as central to other disciplines, because IT has become a critical enabler of business processes in other functional areas of business. The work on IT impacts on financial market microstructure and the interactions of informed and uninformed traders with market-making intermediaries are good examples. The relevance of this IS research extends well beyond the borders of the IS field.

A third trend reflects IS researcher interest in new theoretical perspectives and refining them for application in IS and electronic commerce. The literature we reviewed has brought new theories to change our perspective about what constitutes a meaningful contribution to IS managerial knowledge. Future theoretical research on e-business themes (e.g., price rigidity and menu cost theories, theories of market unity and market fragmentation, theories of channel power and firm distribution channel choices, theories of principal-agent monitoring costs) will move in a similar direction.

7. Conclusion

The purpose of this review article has been to provide *Management Science* readers with a retrospective view of the research contributions that form the foundational knowledge in the field of information systems. We identified five major streams of research based on the reach of theoretical perspectives in dealing with important managerial issues, and the range of methodologies and techniques to study different empirical settings. Although the approaches, problems studied, and results represent a diversity of contributions that underlie the research that is occurring in the field today, much of the work that has been published here informs managers about the central problems associated with the management of IS.

We expect that future IS research will continue to be characterized by the study of problems in IS management, including systems analysis and design, the management of software and IT investments within the firm, the configuration of business processes and the formation of business strategies that rely on IT, and the continued use of IT to create unique capabilities for users, decision makers, work groups, organizations, and industry sectors. At its best, IS research has the potential to inform managers and academicians about how to understand, interpret, adapt to, and effectively manage technologies that have been and currently are in use, as well as emerging technologies whose impacts are just being felt. If this capability can be brought to bear more strongly on the IS management function, there will be significant leverage to make one of the important business functions within the contemporary firm deliver on the promises that IT investments are supposed to offer. Clearly, however, there remains much more research to accomplish this. IT infrastructure development, software project management practices, creation of technology standards, optimizing networking capabilities for the firm, and structuring interorganizational IS investments deserve increased attention. All of these issues require careful consideration of how IT impacts other management functions. Consequently, we also expect that the extent of interdisciplinary research in the IS field will increase, as other fields recognize the importance of developing knowledge related to specific problems that arise which are best assessed with an information systems view in mind.

Although other fields, including economics, operations research, organizational theory, and strategic management, will continue to play a key role in the development of managerial knowledge of IT, researchers in the IS field have an opportunity to leverage their in-depth knowledge of technology and the work group, organizational, market, and economy settings in which it is deployed. This will require thoughtful problem selection, exploitation of knowledge of the role of information systems, and the ability to recognize situations where management science techniques make a difference. IS researchers will span the boundaries of disciplines such as marketing, operations, accounting, finance, organizational behavior, and strategic management as they explore the value created by IS and IT in different activities of a firm or an industry value chain. *Management Science* will continue to present an excellent place for researchers to publish interdisciplinary work in which various perspectives are bought together to understand the managerial implications of IT.

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