Information Systems Innovation Among Organizations

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In an era of revolutionary new developments in basic information technology, innovation in its employment among organizations is increasingly crucial to competitive survival and success. The Information Systems (IS) unit within the business is largely responsible for meeting this challenge. Yet, current theory explains little about IS innovation and its role in organizational innovation in general. We suggest some needed foundations. IS innovations are posited to be of three types: Type I innovations confined to the IS task; Type II innovations supporting administration of the business; and Type III innovations imbedded in the core technology of the business. Diffusion among organizations is conjectured to occur by means of a communication circuit in which each IS unit is linked to its professional and business environments. Systematic differences in adoption and evolution patterns among IS innovation types are expected. Three specific IS innovations—data administration, the information center, and material requirements planning (MRP)—illustrate.
(*Information Systems; Innovation Types; Innovation Adoption and Diffusion; Innovation Evolution*)

Introduction

Today, organizations of all kinds face what has been termed a social sweep, in which new, microelectronic information technology is spreading at "an astounding rate to an amazing number of people, organizations, and applications" (Mohr 1987, pp. 16–17). The implications of this sweep are profound (Huber 1984). In particular, "The meshing of new technology with organization design, process, strategy, and external relationships appears to be one of the most important issues of the next decade" (Pennings and Buitendam 1987, p. xiv).

At the center of this change in many organizations is the Information Systems (IS) unit, whose task is itself in a state of flux, with traditional system development and operations activities now supplemented with newer activities such as data administration, network management, information center services, and many others, reflecting in part an expanded mission (Zmud 1984b). At the same time, the rapid rise of end-user computing (Henderson and Treacy 1986), has led some (e.g. Dearden 1987) to question the future viability of today's centralized mainframe-based IS unit. Indeed, the present investment in computing resources is increasingly distributed and decentralized (Keen 1985).

Notwithstanding this turmoil, the widespread impacts of IS on the businesses it serves are increasingly acknowledged to be fundamentally strategic, as new information technology continues to progressively penetrate core business technologies (Porter and Millar 1985). There is thus no returning to an age of innocence of information technology within the business.

How should these substantial changes and developments be best understood and what are their management implications? Broadly speaking, it is of course by means of organizational innovation that any enterprise can and should respond to fundamental change in its environment. New opportunities and constraints suggest new organizational products and processes, both for the business as a whole and for its various internal sub-units such as IS, and failure to adapt threatens overall health and survival. Understandably, therefore,

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in an era of revolutionary new advances in basic information technology, IS innovation is in particular increasingly crucial to the many businesses served. For while creative uses originate in many places, it is by means of IS innovation that the new technology is effectively meshed with organization design, process, strategy, and external relationships throughout the enterprise.

Historically, innovation has been the very business of IS in organizations, even though it has not always been recognized as such, since IS's inception as a functional unit in the 1950s. The early computerization of routine accounting produced substantial organizational changes in this well-entrenched administrative task, for example. Yet, while innovation is a subject which has been widely studied by social scientists, and while a substantial literature exists on organizational innovation in general, this literature has until recently been little extended to IS innovation in particular. As a consequence, while business innovation now depends increasingly on IS innovation, the nature and significance of the latter remains underexplored.

In this paper, we aim to break new ground for the study of IS innovation. We address basic questions. What is an IS innovation and how does it differ from other organizational innovation? Are IS innovations different among each other in important ways? By what mechanisms do they originate and diffuse among organizations with what consequences? Who are the likely innovators—the first and early adopters? Why do IS innovations tend to evolve over the course of their diffusion and what patterns are characteristic of these changes? These questions are not yet well answered in the current literature.

In considering these issues, we conclude that a widely-accepted dual core model of organizational innovation (Daft 1978) should be extended to a tri-core model to account for IS innovation. We identify a typology of IS innovations mapped to the tri-core model. We posit an IS innovation diffusion circuit to explain hypothesized differences in patterns of adoption and evolution of the different types. We illustrate the implications for three IS innovations: data administration, the information center, and material requirements planning (MRP). We conclude by drawing the broader research implications.

Existing Studies of IS Innovation

While the literature on organizational innovation is very large (Rogers 1983, Tornatsky and Fleischer 1990), relatively little of it focuses on IS innovation. Here, we selectively review the research to date on IS innovation. We first introduce basic concepts and theory which originate in the more general literature. We then summarize some 22 studies of IS innovation, and assess present difficulties in relating IS to overall organizational innovation, setting the stage for our own theory development.

Basic Concepts and Theory

Briefly, we reacquaint ourselves with the concept of organizational innovation, and with the phenomenon of innovation diffusion, upon which we focus principal attention.[1] Distinctions are made in the literature among adopters of innovations, among innovation types, and among an innovation's process phases. We point to the importance of these distinctions in the present paper.

What is organizational innovation? Most broadly, organizational innovation refers to "the adoption of an idea or behavior that is new to the organization adopting it" (Daft 1978, p. 197). More narrowly, innovation is defined as "the first or early use of an idea by one of a set of organizations with similar goals" (Becker and Whisler 1967, quoted by Daft 1978). Here, only a first or early adopter of an innovation within an organizational population is understood to be an innovator.[2] In

[1] Rogers (1983) provides the authoritative history and assessment of the innovation diffusion literature. Diffusion studies began in the 1940s with an examination of the use of hybrid seed corn among farmers. Since then, there have been diffusion studies in virtually every area of social and organizational technology deployment (Tornatsky and Fleischer 1990). Research on organizational innovation intersects with this literature. Beyond diffusion studies, the organizational innovation literature also focuses on the sources of innovation and the inventive process (see, e.g., von Hippel 1988). Invention, as distinct from innovation, involves the creation of the idea or behavior (see Becker and Whisler 1967, Pierce and Delbecq 1977). It is largely beyond the scope of the present paper.

[2] Rogers (1983) classifies adopters according to time of adoption, assumed normally distributed. First and early adopters constitute about 16% of the adoption population. Rogers reserves the term "innovator" to be synonymous with first adopters, the venturesome first 2.5% of adopters. Early adopters, the next 13.5%, serve as "respectable" role models for those who follow. Rogers thus takes a still narrower view of innovator than does Daft (1978), upon whom we rely. But Rogers' focus is on individual, more than organizational, adoption.

the present paper, we shall be interested in how an IS innovation spreads within a population and we shall use the term "innovator" in the narrower sense; however, we will not focus only on first and early adoption.

Diffusion of an innovation refers to the pattern of its adoption by an organizational population over time. Given a normally distributed time of adoption, the cumulative pattern follows the common S-shaped curve (Rogers 1983). The apparent success of innovators is frequently assumed to motivate imitative behavior by others (Alchian 1950). Understanding how alternative channels of communication facilitate the adoption process is thus a central research concern (Rogers 1983). In the present paper, we will argue that these channels are significantly differentiated according to IS innovation type.

Importantly, innovators may be distinguished from later adopters based on internal organizational characteristics, such as size, for example. Among later adopters such characteristics are not predictive, however, which Tolbert and Zucker (1983), from their study of the diffusion of civil service reform into U.S. city governments, interpret as evidence of the institutionalization of innovations among organizations, where innovations become taken for granted as good management practice. They conclude, "The legitimacy of the procedures themselves serves as the impetus for the later adopters" (p. 35). Here we shall be concerned with how such internal organizational characteristics affect IS innovation, noting that IS work is frequently carried out within a functional sub-unit of a larger host organization, complicating the analytical task.

Innovations may themselves by typed. Robey (1986) distinguishes among new products (or services), administrative innovations (improving internal control, coordination, and structure), and technical innovations (changes to technology or work processes). Zmud (1982) distinguishes between product innovations ("the introduction of new products or services that shift or expand an organization's domain") and process innovations ("the introduction of new methods, procedures or responsibilities within existing domains"). Process innovations include both administrative and technical innovations.[3]

[3] See too Utterback and Abernathy (1975).

Innovation types are significant in part because research findings suggest that facilitation factors vary among them, and, further, that adoption sequence and timing may also vary systematically. Thus, for example, Daft (1978) proposes a dual-core model to explain differing characteristics of administrative and technical innovations. From a study of 13 suburban high school districts, he concludes that "it seems likely that low formalization, decentralization, and high complexity (professionalism) are suited to both initiation and adoption of innovations within the technical core. The opposite structural conditions facilitate innovation in the administrative core" (pp. 207–208). Daft (1982) provides an extended discussion. In this paper, we will argue that Daft's model may be extended to a tri-core model to account for IS innovation.

Similarly, Damanpour and Evan (1984) present a study of "organizational lag" in innovation, based upon Evan's (1966) hypothesis that administrative innovations in organizations tend to lag behind technical innovations. Among the possible explanations of such a lag: ". . . technical innovations are more observable, have higher trialability, and are perceived to be relatively more advantageous than administrative innovations, while administrative innovations are perceived to be more complex than technical innovations to implement" (Damanpour and Evan 1984, p. 394). From their study of eighty-five public libraries, the authors conclude that the two types of innovation complement each other in high-performance organizations. Specifically, ". . . it is the combination of related changes in the social and technical systems that help to maintain the level of performance in response to an environmental change" (p. 406). Below, we will find this idea useful in explaining how an IS innovation tends to evolve in nature over the life course of its successive adoption among organizations.

Innovation may also be viewed as an organizational process within which various phases or stages may be distinguished. Pierce and Delbecq (1977) review the literature and judge Thompson's (1965) three-phase model, which consists of initiation, adoption, and implementation, to be the most representative. Importantly, research suggests that factors facilitating innovation in its early phases may be the reverse of those facilitating the later phases. (Wilson 1966 gives a com-

pelling theoretical interpretation.) In the present paper, noting that a complex innovation is often "re-invented" during its implementation (Rice and Rogers 1980, Rogers 1983), we will find that this helps explain the course of an IS innovation's evolution.

Finally, the organizational process perspective also underscores the fact that whether an innovation has occurred or not is subject to ambiguity, where the phase is not carefully specified. (Van de Ven 1986 argues that implementation, not just adoption, is necessary to innovation, for example.) Similarly, the depth of adoption, i.e., penetration, of an innovation within an organization also varies, with significant ramifications for organizational comparisons (Downs and Mohr 1976). Certain innovations offer considerable latitude in usage and must be accepted within the organization among "secondary adopters" in order to be effectively implemented (Leonard-Barton and Deschamps 1988). This will be seen to be particularly important to IS innovations.

Information Systems (IS) Innovation

Information systems (IS) innovation may be broadly defined as innovation in the organizational application of digital computer and communications technologies (now commonly known as information technology, or IT). It is fundamentally organizational innovation, whether it is analyzed from the vantage point of the entire organization, or from a lower level, that of one or more of the organization's adopting subunits, or even at the individual level among a subunit's secondary adopters. More narrowly, for our purposes, we will associate IS innovation with the work of an organization's IS department, wherein the responsibility for successful IS innovation throughout a functionally differentiated organization principally lies.[4] This responsibility is of course shared with those other subunits served by the IS department. Indeed, the success of IS innovation may rest upon an effective partnership between the IS department and its users, and, moreover, users may be the sources of certain IS innovations, as we discuss below. Parties external to the host organization—consultants, vendors, and providers of outsourced services—will also be seen to play important roles in the overall IS innovation process (Attewell 1992).

IS innovation and its diffusion at any organizational level has until recently been relatively little studied by researchers. In particular, at the level of the IS department, few research studies to date have addressed basic questions such as those factors which distinguish earlier from later adopters and the determinants of the innovation's pattern of adoption and diffusion over time. In general, the most noteworthy empirical studies of IS innovation at all levels of adoption date from the early and mid-1980s. We summarize a number of these in Table 1, to place our own work in context, and comment on several briefly.[5]

A variety of IS innovations have been studied, ranging from IS work practices such as the use of data base design tools and techniques (Nilakanta and Scamell 1990) to user-oriented industry-specific IS technologies such as electronic scanners for supermarkets (Levin et al. 1987, Zmud and Apple 1992). However, few innovations have been the subject of more than one study and most studies have focused on a single innovation. In general, how innovation adoption and diffusion should differ if at all across such a variety of IS innovations has been ignored. Only Zmud (1982, 1984a) addresses this issue in his studies of the diffusion of modern software practices among IS development groups. Following Daft (1978), Zmud (1982) contrasts administrative with technical innovations, hypothesizing, however, differences in the effects of centralization and formalization among innovation phases. While findings are mixed, organizational size and professionalism are found to be positively related to the initiation of technical innovations. Zmud (1984a) provides additional insights.

While Zmud's (1982, 1984a) work thus usefully applies the distinction between technical and administrative innovations to the IS context, it limits its attention to innovations largely internal to the IS department. Perhaps for this reason, it also does not consider the larger organizational context in which IS work takes

[4] Our reference to an organization and its IS department is broadly conceived. The organization may be a functionally differentiated hierarchy or sub-hierarchy of any form. The IS department is simply that functional unit responsible for IS within the hierarchy or sub-hierarchy. We assume for present purposes that there is only one such unit.

[5] For another recent review, which covers 18 empirical studies, including 11 beyond those listed in Table 1, see Fichman (1992).

Table 1 Selected Empirical Research in IS Innovation

Reference	Innovation	Adopting Unit	Remarks
Attewell 1992	Business Computing	Firm	Service bureaus found to mediate diffusion
Ball et al. 1987/88	DBMS	Firm	Adoption explained by general innovativeness of firm
Bayer and Melone 1989	Software Engineering Technology	Firm	Focuses on differences in technology advocate, transfer mechanism, and perceived advantages
Brancheau and Wetherbe 1990	Spreadsheet Software	Professional	Illustrates individual, user-led, IS-related innovation
Burkhardt and Brass 1990	General Purpose Individual Computing	Professional (Agency Member)	Illustrates penetration of organization-led IS innovation
Cooper and Zmud 1990	MRP	Firm	Adoption explained by match of innovation to manufacturing environment
Fuller and Swanson 1992a, 1992b	Information Center	IS Department	Host organizational factors significant in early adoption and implementation success
Hannan and McDowell 1984	ATMs	Firm	Adoption explained by firm size and local market concentration
Hsieh 1987	Data Administration	Firm	Early adoption associated with prior adoption of DBMS
Huff and Munro 1985	New Information Technology	IS Department	Identifies initiation and adoption strategies
Leonard-Barton and Deschamps 1988	Expert System (Firm Specific)	Professional (Sales Person)	Focuses on implementation through secondary adoption
Levin, Levin, Meisel 1987	Electronic Scanners	Firm (Supermarket)	Early adopters are non-chain firms with large store size in non-concentrated markets
Lind and Zmud 1991	IS Services	User Department	Explains innovativeness by common understanding between IS and users
Loh and Venkatraman 1992	IT Outsourcing	Firm	Adoption pattern explained by imitative behavior
Manross and Rice 1986	Intelligent Telephone	Office Complex (within firm)	Examines user acceptance and rejection in implementation
Moch and Morse 1977	Administrative EDP	Organization (Hospital)	Adoption explained by size and functional differentiation
Moore and Benbasat 1991	Personal Work Station	Professional and Clerical	Focuses on an instrument to measure perceptions of individual adopters
Nilakanta and Scamell 1990	Data Base Design Tools and Techniques	IS Professional	Examines effects of information sources and communication channels on diffusion
Perry and Danziger 1980	Computer Applications	Local Government	Adoptability of innovation explained by its visibility and by staff competence
Ramiller 1991	CASE	IS Professional	Focuses on perceived compatibility of innovation
Zmud 1982, 1984a	Modern Software Practices	IS Department	Size and professionalism explain initiation of technical innovations.
Zmud and Apple 1992	Electronic Scanners	Firm (Supermarket Chain)	Early adoption explained by chain size. Focuses on penetration within chains.

place. It examines IS units as if they were independent, self-contained organizations, whereas, in fact, most exist as departments of larger business units in which innovation is of further, related importance.

Among those studies which focus on IS innovation diffusion at the firm level, Moch and Morse (1977) attribute the adoption of administrative EDP among hospitals to organizational size and functional differentiation. They do not identify the innovators among the adopters, however. Ball, et al. (1987/88) report that innovative software, specifically database management systems (DBMS), is more likely to be acquired by firms seen to be innovative more generally. Adopters are also found to have relatively large IS departments. Cooper and Zmud (1990) find adoption of material requirements planning (MRP) systems predictable by the match in MRP's underlying assumptions to the manufacturing environments for which MRP is considered. However, they do not identify the MRP innovators. Despite such limitations, taken together, these studies clearly confirm the importance of firm-level effects in the adoption and diffusion of IS innovations.

To our knowledge, only Lind and Zmud (1991) have examined IS innovation in terms of the interaction between the IS department and user departments. Here the relative IS innovativeness of user departments within two co-located divisions of a single firm is assessed. Differences between divisions (if any) are not reported.

Various other diffusion-oriented studies focus upon the penetration of an IS innovation within a business, rather than upon the adoption and diffusion of the innovation among businesses. Here, adoption by the organization is often presumed and the issue is the subsequent spread of the innovation among individual secondary adopters. Substantial organizational-level implications are sometimes identified. Thus, Leonard-Barton and Deschamps (1988) explored the role of managerial influence in the secondary adoption of an expert system by the sales professionals of one firm, finding that influence was perceived very differently among the professionals. Burkhardt and Brass (1990) examined the secondary adoption of a general purpose computing system among members of a federal agency, finding that earlier users tended to increase their power and centrality relative to later users within the organization, as the system introduced significant discontinuity and uncertainty into the agency's core task. Brancheau and Wetherbe (1990) studied the adoption of spreadsheet software among finance and accounting professionals within a variety of firms, finding diffusion to be substantially a user-led, rather than IS department-led phenomenon. In general, a problem with these and other studies of the secondary adoption process is that we do not learn how the process may be contingent on whether the organization itself is an early adopter of the innovation.[6]

Finally, it should be mentioned that much of the substantial literature on IS implementation (see, e.g., Lucas 1981, and Swanson 1988) also addresses secondary adoption and penetration of IS innovations. However, this work also does not generally consider whether implementation problems depend on the extent to which the organization is a first or early adopter of the IS innovation, nor does it usually consider the nature of the innovation.[7]

Summary

Existing research on IS innovation is both fragmented and limited. While organizational innovation theory has been selectively applied in IS contexts, it has not been significantly elaborated upon or extended. No theory of IS innovation in its particulars is distinguishable from organizational innovation theory in general. There exists no useful typology of IS innovations, which in consequence are differentiated neither among each other, nor from other, non-IS innovations. Nor is IS innovation typically viewed in the larger organizational context in which innovation takes place. For these reasons, surprisingly little about the contribution of IS innovation to the businesses ostensibly supported can be said. This fails to serve not only IS theory, but organization theory in the long run.

Recall that a defining characteristic of organizations—indeed, a sine qua non—is their internal functional dif-

[6] Further reflecting the importance of secondary adoption of IS innovations among individuals, Moore and Benbasat (1991) develop an instrument to measure individual adopter perceptions. Ramiller (1991) explores the dimensionality of the perceived compatibility construct among secondary adopters.

[7] Kwon and Zmud (1987) usefully map IS implementation research to the literature on innovation diffusion.

ferentiation. Because functional tasks vary and are often the focus of innovation (Stinchcombe 1990), innovation certainly arises within and among selected organizational sub-units, as much as it does within and across the organization as an integrated whole. But organizational innovation theory to date has focused on a single notion of relevant internal differentiation, that between the technical and administrative cores. While important, this simple distinction is inadequate for purposes of explaining IS (and, possibly, other professional sub-unit) innovation.

The IS function as an organizational sub-unit has two distinctive features which pose a problem for current innovation theory and its limited notion of relevant internal differentiation. First, IS permeates both the technical and administrative cores; indeed, it provides an informational layer which links the two, as we discuss further below. Thus, IS innovation spans both cores and is unlikely to be characteristic of innovation local to either. Second, IS is founded upon its own specialized technology, viz. information technology, which is rapidly elaborating and possesses an unusual degree of plasticity for informational layering and organizational linking. IS has its own professional knowledge base which in most organizations is substantially disjunct from those of the administrative and technical cores.[8]

Below we explore how IS innovation is shaped by these distinctive features. We build from what is known about organizational innovation more broadly. But we go beyond this to show how such innovation at the firm level may be explained in terms of innovative activity at the differentiated sub-unit level; we focus on the IS sub-unit, where we believe the linkage to the firm's innovation is a profound one. We argue that what is needed is theory in which differentiated IS innovation is tied specifically to business innovation.

Toward a Theory of IS Innovation

We seek here to establish groundwork for a theory of IS innovation among organizations. Consistent with the above analysis, we impose two desiderata upon these foundations: (i) that they support the development of theory specific to IS; (ii) that they support an IS-specific theory with direct implications for organizational innovation in general.

We begin by proposing a basic typology of IS innovations. Distinguishing among innovation types is fundamental to effective theoretical development (Downs and Mohr 1976, Moch and Morse 1977, Pennings 1987). We base our typology in a straightforward extension of Daft's (1977) dual core model of organizational innovation. We then explore the contextual structure for IS innovation and posit a unique innovation diffusion circuit. This suggests several propositions for the adoption, diffusion, and evolution of IS innovations of the different types.

A Typology of IS Innovations

How should IS innovation be understood? Recalling basic concepts discussed above, IS innovation may involve a new IS product or service, a new IS work technology, or a new IS administrative arrangement. Each of these reshapes the content, extent, and organization of the IS task. Only the first extends IS innovation beyond the confines of IS itself, however. IS innovation influences and reshapes the host organization directly only where IS's products and services impact upon the host's basic business processes and products. Here impacts may be on either or both the business's administrative and technical work processes.

Beyond the issue of impact upon the business, IS innovations may further be characterized in terms of certain fundamental features. Such features include both new information technology (hardware and software and their immédiate extensions, such as databases and transaction records) and new forms of human work and organization (means for applying hardware and software). Most IS innovations will incorporate both information technological and work organizational features, though not necessarily in the same proportion. Some innovations will be dominated by information technological features, as with the adoption and implementation of a new database management system, while others will be dominated by work organizational features, as with the establishment of an IS strategic planning unit. Feature compositions will also tend to evolve

[8] Some may wish to argue that these distinctive features are more a matter of degree than of kind. Other functional areas, in particular, accounting, may share these same features to some extent. But the role of accounting in binding the technological and administrative cores has waned in recent years, while that of IS continues to grow (Johnson and Kaplan 1987).

over time, we argue later; core elements will not be static as traditionally assumed by innovation diffusion theory (Tornatsky and Fleischer 1990). Organizational lag will characterize this evolution; work organizational features will often lag information technological features.

The overall domain of IS innovation may therefore be mapped on two basic dimensions: (1) business impact and (2) technological and organizational feature composition. We focus on the business impact dimension in proposing a basic IS innovation typology. (We speak further to the second dimension in later sections of the paper.)

Recalling the dual-core model of organizational innovation (Daft 1982) discussed above, we suggest an extension of this model's administrative and technical cores to incorporate a third, functional IS core, serving to link the other two cores together. As will become apparent, this serves to illuminate IS innovation among organizations, in terms of business impact, where the current dual-core model mostly masks it. The resulting *tri-core model* of IS innovation may be portrayed (for ease of recall) as in Figure 1.[9] Here the domain of IS innovation is understood to incorporate both the functional IS core and the business administration and technology cores via IS products and services. It also ranges over the value added process of the business, as described by Porter (1985). Three basic types of IS innovations, termed Types I, II, and III, are posited, mapped to the three cores.[10] We discuss each briefly, and identify several important sub-types. We illustrate and summarize in Table 2.

Figure 1 **The Domain of IS Innovation in Organizations: A Tri-Core Representation**

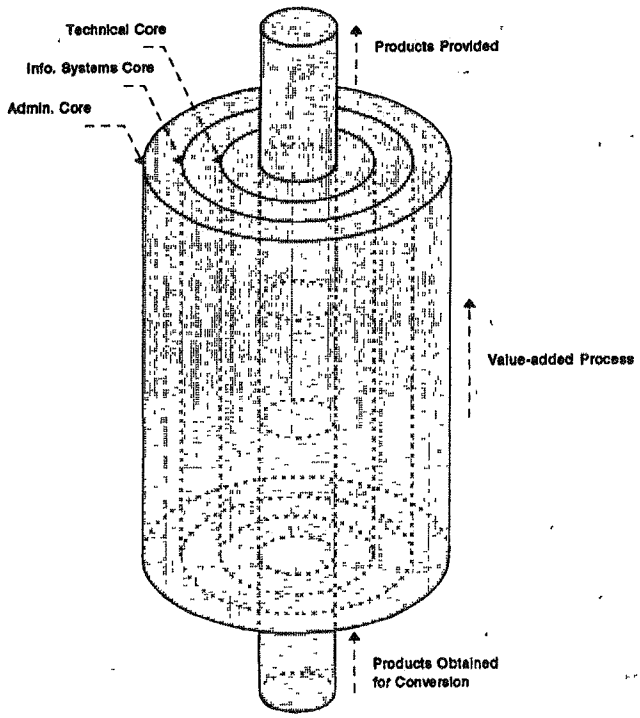


Table 2 **IS Innovation Types**

Innovation Types	Description	Illustrations
Type Ia	IS Administrative Process Innovation	Maintenance Departmentalization (1970s and 1980s) Chief Information Officer (1980s)
Type Ib	IS Technological Process Innovation	Systems Programming (1960s) Chief Programmer Team (1970s) Data Administration (1970s and 1980s) Application Prototyping (1980s)
Type II	IS Product and Business Administrative Process Innovation	Accounting Systems (1950s) Information Centers (1970s and 1980s) Executive Information Systems (1980s and 1990s)
Type IIIa	IS Product and Business Technological Process Innovation	Material Requirements Planning (1950s and 1960s) Airline Reservations Systems (1960s) Computer Integrated Manufacturing (1980s and 1990s)
Type IIIb	IS Product and Business Product Innovation	Airline Reservations Systems (1970s and 1980s) Remote Customer Order Entry and Follow-on Customer Service Systems (1980s)
Type IIIc	IS Product and Business Integration Innovation	Interorganizational Information Systems (1980s) Electronic Data Interchange (1980s and 1990s)

Type I *innovation* is defined as process innovation restricted to the functional IS core. Other aspects of the

[9] Following Daft (1978), we use the term "model" very loosely here to refer to our reasoning about the differentiation of the cores. Figure 1 is intended only as an iconographic summary.

[10] As will be seen, actual IS innovations need not always conform to these pure types. Hybrids are possible. Our typology serves primarily analytic purposes.

business are mostly indirectly affected, through gains in IS efficiency, for example. Type I innovation may focus upon the IS administrative task, that is, upon the management and administrative support of IS work, as with the departmentalization of the software maintenance function (Swanson and Beath, 1990), or as with the adoption of the concept of the chief information officer (Bock, 1986). Or it may be centered on the technical IS task itself, as with introduction of systems programming in the 1960s, or the introduction of the chief programmer team in the early 1970s, or the use of application prototyping methods in the 1980s. Here the nature of IS work itself is changed. Where the focus is on IS administration, the innovation will be termed a Type I(a) innovation; where it is on the technical IS task, it will be termed a Type I(b) innovation. Together, these two sub-types comprise Type I innovation, or IS process innovation.

Notwithstanding its limited focus, Type I innovation is likely to have second-order effects beyond the confines of the IS unit. Departmentalization of software maintenance may support a new service orientation by IS, for example (Swanson and Beath 1990). The chief information officer may be specifically charged with identifying strategic applications for the business. And prototyping in system development may involve a new and more responsive working relationship with business users. Thus, Type I innovation may be supportive of business innovation more broadly. Still, its second-order effects are on the whole likely to be what we shall term *weak-order effects*; they may support but they do not compel innovation elsewhere.[11]

Type II *innovation* applies IS products and services to the administrative core of the host organization business. Core business technology for the production of the organization's goods and services is not directly affected. The introduction of automated financial accounting systems in the 1950s is exemplary. Payroll and personnel record systems, introduced around the same time, provide a second example. Both illustrate the early history of IS's impact upon the business, which was largely upon its administrative processes and infrastructure. The advent of the information center in the late 1970s and 1980s provides a more recent example of general administrative support, discussed below. Significantly, Type II innovation is likely to have important ramifications for the internal IS work process, beyond its primary focus on business administration. Thus, for example, the development of application specialists among systems analysts has accompanied the accumulation of diversified portfolios of IS products and services. Similarly, the provision of information center services has involved the creation of a self-contained work unit for this purpose. Type II innovation may therefore incorporate certain aspects of Type I innovation; or it may provide the seed for their subsequent origination. Because these second-order effects are likely to be compelling, we shall term them the *strong-order effects* of Type II innovation.[12]

Type III *innovation* integrates IS products and services with core business technology, and typically impacts upon general business administration as well. The whole business is potentially affected, and the innovation may well be strategic, in terms of offering competitive advantage to those who are among the early adopters (while later adopters are forced to play catch-up). This advantage accrues either through product or service differentiation, or through low cost production (Porter 1985). The introduction of material requirements planning (MRP) systems in manufacturing in the 1950s and 1960s illustrates and is discussed further below. The introduction of airlines and other realtime reservation systems in the 1960s further illustrates (Porter and Millar 1985, Malone et al. 1987, Copeland and McKenney 1988). The concept of computer integrated manufacturing (CIM) also provides an interesting case (Doll and Vonderembse 1987), as it incorporates a bundle of varied innovations (e.g., computer aided design and manufacturing, automated materials handling, and manufacturing resource planning) under its rubric, forming what has been termed a "technology cluster" (Rogers 1983).

It will be useful to distinguish among three sub-types of Type III innovation. Type III(a) is defined as centered

[11] Certain weak-order effects may nevertheless be important, as we shall see in the case of data administration.

[12] We distinguish no sub-types among Type II innovations. Elsewhere, making such distinctions among administrative innovations might be useful; the determinants of technical innovations in accounting might be very different from other administrative innovations, for example. This is beyond the scope of the present paper, however.

on the business's core work process, as for example, with MRP. Type III(b) extends to basic business products and services. Here, information technology may be inherent to or imbedded in a product, as, for example, with in-house software which is also marketed commercially, or it may be incorporated within a service, as with systems which support follow-on customer service after a product sale (Ives and Vitale 1988), or as with the reservation system service which accompanies air travel. Type III(c) innovation provides for the integration or effective coordination of the business with its suppliers or with its distributors or customers. New organizational boundaries may be drawn through systems supportive of either classical vertical integration (Chandler 1977), or of decentralization and the development of new markets (Malone et al. 1987), or of the development of intermediate organizational forms such as long-term coordinated contracting relationships (Child 1987). Interorganizational systems requiring transaction-specific investments shared among organizations provide one class of illustrations, where certain of the participants may find themselves heavily bound by switching costs in their commercial transactions with one or more others (Cash and Konsynski 1985). The introduction of EDI (Electronic Data Interchange) in support of standardized commercial transaction processing provides a related, contrasting illustration, emphasizing the important role of industrial standards in IS innovation (Schatz 1988, Hansen and Hill 1989).[13]

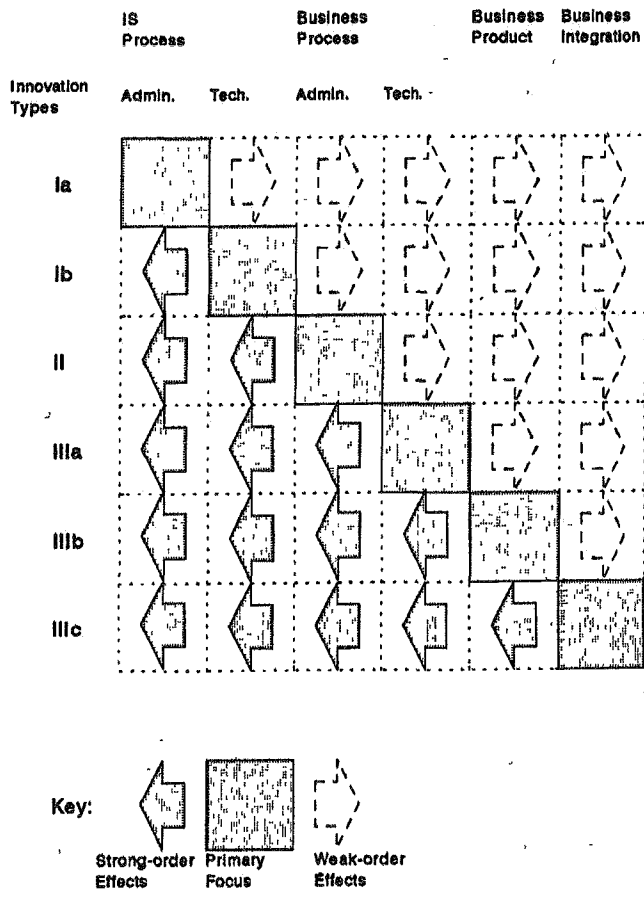
Type III innovations of all three sub-types are likely to have strong-order effects on innovations of the other basic types. An IS innovation in follow-on customer service may call for new forms of administrative accounting and reporting, for example, and for new job definitions and skills within IS itself.

Certain Type III innovations may further incorporate aspects of all three sub-types, as in the case of the airline reservations systems which reshape both the overall business process and product, and further establish binding ties of travel agents to specific airlines (Copeland and McKenney 1988), while offering the longer-run prospect that the reservation service may eventually emerge transformed as a fully self-contained business (Malone et al. 1987).

Organizations may therefore be strategically compared in terms of their adoption of Type III innovations. For instance, within an industry where Type III innovations are significantly represented, but are not yet institutionalized, IS is likely to be of current strategic importance to the industry's businesses. (Once such innovations are institutionalized, there is no competitive advantage, only competitive parity, to be gained in their adoption.)

Figure 2 summarizes and elaborates upon the comparative domains of the three innovation types and their sub-types, and relates IS innovation to overall business

Figure 2 The Relationship of IS Innovation to Business Innovation



[13] Because Type III(c) innovation focuses on the coordinated exchange of basic products and services, we classify it as innovation based in core business technology. Nevertheless, it is also likely to incorporate aspects of administrative and IS infrastructure in order to effect the coordination (imagine two tri-core systems from Figure 1 connected fully end-to-end). EDI provides a good example. For this reason, some may wish to argue that it constitutes a distinct innovation type in its own right.

innovation. In terms of the distinction between process and product innovations drawn above, Type I innovation constitutes an IS process innovation, while Type II and III innovations involve IS products in the service of basic business processes and products. Type II innovations support the business administrative process, while Type III innovations focus upon core business products and processes. Higher order innovations are shown as having increasingly broad ramifications in terms of strong-order effects across the overall business domain.

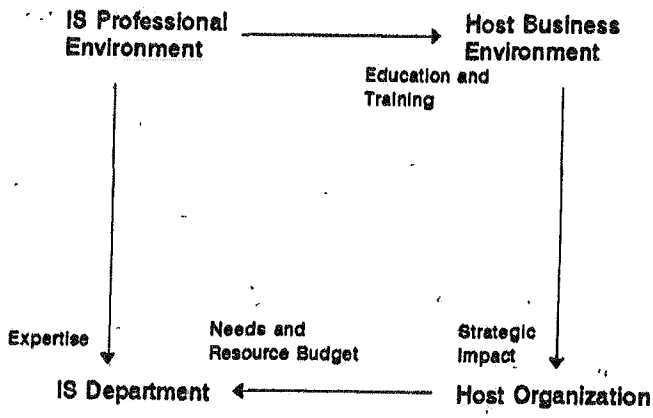
Significantly, innovations of all three types are likely to evolve over time across their domains, as they are successively adopted. Both strong-order and weak-order effects provide impetus for this evolution, which is marked by incremental changes to the innovation's feature composition. New features are likely to be introduced to complement existing features, reconfiguring the concept and often facilitating the adoption process. We discuss and illustrate this below. First, however, we address the issue of the basic mechanism for the diffusion and evolution of the IS innovation.

The Contextual Structure of IS Innovation

How do IS innovations of different types originate and diffuse among organizations? How is this process the same or different than for any other innovation? In this section, we address these questions. We suggest a unique contextual structure for IS innovation, with important ramifications for both diffusion and evolution. The importance of environmental and organizational contexts in this process is emphasized (Tornatsky and Fleischer 1990).

Specifically, we propose that IS innovation may be understood in terms of the contextual structure portrayed in Figure 3. This structure consists of dual organizations—the IS unit and the host organization it serves—and dual environments—the IS professional environment and the host business environment. Each of the dual organizations operates within the conjunctive context of its own environment, and in relationship to the other organization, and the two environments are themselves linked. The overall structure incorporates a communication loop which provides the mechanism—an *innovation diffusion circuit*—by which the innovation is posited to spread among organizations.

Figure 3 The IS Innovation Diffusion Circuit



Because the IS unit serves the host organization, and not vice versa, the organizational duality shown is not symmetrical. Rather, IS typically exists as a department within the host organization. Similarly, the IS professional environment is a component of the larger business environment among industries.

The proposed structure suggests that variance in IS innovation should be explainable in part in terms of corresponding variance in the fundamental relationships of the IS unit to its host organization and to its professional environment. Broadly speaking, these relationships may be seen in terms of "tight" or "loose" coupling (Weick 1979). To an important degree, an IS unit may often be tightly coupled in one of its two fundamental relationships only by means of loose coupling in the other.

The IS unit depends upon the host organization for its resource budget, and upon its professional environment for its expertise. Both constitute fundamental dependencies, and are the basis for tight or loose coupling. In return for its resource budget, the IS unit provides services to meet the host organization's business needs. In return for expertise, it provides professional employment.

Where the IS unit is tightly coupled to its host organization, it may be characterized as *business oriented*; where it is tightly coupled to its professional environment, it may be characterized as *professionally oriented*. The two orientations may be contrasted.[14]

[14] We make this contrast for analytic purposes. We do not suggest that most IS organizations are of one or the other orientation; we *do*

The professionally-oriented IS unit emphasizes its IS expertise. It competes in the marketplace for the best educated and most experienced staff, who rarely are drawn from, or subsequently placed elsewhere in the host organization. It also adopts state-of-the-art information technology, and prides itself on its innovation and quality of work. It tends to be cosmopolitan, more than local, in orientation (Gouldner 1957/1958, Rogers 1983).

In contrast, the business-oriented IS unit focuses upon the net worth of its services to the host organization. Knowing the host organization's business is emphasized, and IS staff are often drawn from, or subsequently placed in positions within this business. Identification with the expressed goals of the business is the touchstone of IS work. Orientation is likely to be local, or else cosmopolitan with respect to the host organization business, more than IS.

Most IS units exist in a balance between professional and business orientations. Resource scarcity ensures attention to the business; technological change fuels the need for new professional expertise.

As indicated in Figure 3, the IS professional environment also interacts significantly with the business environments within which IS offers its services. IS educators and consultants interpret business needs, and tailor IS expertise to business rationality, thus enabling the IS unit to secure needed resources from its host. Similarly, general management is also educated and counseled in its literature on the value of IS. The current interest in "competing with computing" illustrates the phenomenon. (See, e.g., McFarlan 1984.)

The relationship of the host organization to its business environment involves the IS unit only indirectly, with two significant exceptions. The first exception, increasingly common, involves Type III innovations in which information technology and administration is fused with the core technology of the business, as discussed above. The second exception involves businesses whose products and services (e.g., hardware, software, consulting) are marketed to the IS units of other businesses. In this case, the IS unit of the business serves as a customer model. In both cases, IS is likely to be of strategic importance to the host organization business.

Given the contextual structure portrayed, it may be asked: what determines the pattern of IS innovation within a population of organizations? More specifically: (i) what determines the diffusion, i.e., timing and sequence of adoption, by organizations of the IS innovation? And, (ii) what determines the evolution, i.e., pattern of change in features, of the innovative concept over the course of its adoption? In the next sections, we venture some propositions in answer to these questions.[15] We begin with the first question. Here, we seek to differentiate primarily between early and later adopters.

The Adoption and Diffusion of IS Innovations

Consistent with the contextual structure postulated, we conjecture that early adoption of an IS innovation may be explained in part by certain characteristics of the IS unit and its host organization, including each one's size, diversity, and slack resources, but also including, in particular, characteristics associated with the IS unit's application system portfolio and its professional and business orientations. Importantly, these characteristics are conjectured to have different implications for different IS innovation types.

We examine first the IS unit's and host organization's size and diversity, which are likely to be closely related. Both size and diversity are known to be important to innovative activity. Indeed, size is important in part because larger organizations tend to be more functionally differentiated, with a greater variety of specialized tasks. This internal diversity is supportive of innovation, in that it provides incentives for each organization member to define the scope and content of his or her own job (Wilson 1966), and, for that matter, for each group of collaborating members to define and pursue its task in support of its own collective interest.

Size and diversity are also important in that they provide more opportunities for the organization to come

suggest that IS units vary widely in orientation (see, e.g., Swanson and Beath 1989).

[15] The underlying argument will rely upon important elements of economic rationality in the explanation of the adoption, diffusion, and evolutionary process. Actors are assumed to be pragmatic on the whole. IS innovations are presumed to be adopted and diffused and even reinvented because members of organizations learn about them and judge them to be advantageous in some way.

into contact with an innovation conceived externally and known within the IS professional and host business environments. Larger organizations tend to have more individual boundary-spanners, who interact with the environment in more specialized roles, attending professional meetings, for example, providing alternative "gateways" for an innovation's diffusion (Tushman 1977). The effectiveness of these various gateways is likely to differ among IS innovation types, however. Thus, IS unit size and diversity may be important in providing gateways for learning about Type I innovations in the IS process. Host organization size and diversity may be important in providing gateways for learning about Type II and III innovations in the business process.

Larger host organizations also attract management consultants, the principal agents of emulative organizational change, the purveyors, more than the originators, of rational management practice. As seen here, the consultant's business thrives on the early identification of a useful organizational innovation, and on the "packaging" of the features for this innovation in terms of business, as opposed to professional rationale. Consultants accordingly provide leverage for innovation adoption in business-oriented terms, facilitating the diffusion process, especially among large firms. "How to sell it to top management" is the common theme.[16]

In summary, for these related reasons: (P1) Early adoption of an IS innovation of Type I is more likely where the IS unit is large and diversified; early adoption of an IS innovation of Type II or III is more likely where the host organization is large and diversified. Significantly, while this first proposition differs only modestly from conventional wisdom, it has subtle ramifications. There are likely implications for IS centralization or decentralization in the large host organization, for instance. Where IS is centralized with economies of scale, Type I innovation is more likely. Where IS is decentralized into smaller units, Type II or III innovation at the local level is more likely.

[16] As Dimaggio and Powell (1983) observe: "Large organizations choose from a relatively small set of major consulting firms, which, like Johnny Appleseeds, spread a few organizational models throughout the land" (p. 152). This plays an important role in the evolution of the innovation as well, as will be later seen.

Beyond size and diversity, slack resources are also significant for the organization and its IS unit, in that they may be allocated to organizational experimentation, in the form of a pilot project, for example, which may be crucial to innovation adoption and implementation (March and Simon 1958, Cyert and March 1963). Slack resources in the IS unit further serve to buffer it from the periodic cost reduction demands of the business. Type I innovation in the IS process may therefore be feasible even when business times are tight. On the other hand, host organization slack may be needed for Type II and III innovations in the business process. The resources for these innovations are likely to come in major part from the user departments. On the whole, the presence of organizational slack may be fundamental to innovation at all levels and, hence, to the achievement of a firm's competitive advantage (Hirsch et al. 1990).

Thus: (P2) Early adoption of an IS innovation of Type I is more likely where the IS unit possesses slack resources; early adoption of an IS innovation of Type II or III is more likely where the host organization possesses slack resources. Again, this follows conventional wisdom, but with a twist. Because organizational slack is fungible (Tornatsky and Fleischer 1990, p. 161), there are likely implications for IS centralization and decentralization. Where IS is decentralized, IS slack is likely to correlate closely with slack at the local level. But where IS is centralized, IS slack may be significantly greater than or less than organizational slack elsewhere, depending on IS's relative success in competing for scarce resources.

The installed application system portfolio of the IS unit provides another foundation for its innovation. In general, the more elaborated this portfolio, the greater the opportunities to capitalize upon it, typically by drawing upon its established data in support of yet newer applications. Certain applications are in fact likely to be prerequisites for others, and innovative organizations are likely to be those that have already put the needed building blocks in place (Porter 1988). The application systems of a portfolio thus comprise a set of highly specialized and co-specialized assets in complementary support of further IS innovation (Teece 1987).

It helps for these systems as building blocks not to be old ones incompatible with contemporary informa-

tion and work technologies, of course. An aged application system portfolio may pose barriers to further innovation. Competence with older technologies may offer "traps" which make it difficult to shift to new and potentially better technologies (March and Sproull 1990). The older the systems, the more pernicious may be these traps. Effective maintenance and renewal of systems is therefore critical (Swanson and Beath 1989). Older systems may eventually need to be replaced altogether in order to provide better architectural foundations. And, in summary: (P3) Early adoption of an IS innovation of Type II or III is more likely where the IS unit has a large but not aged application system portfolio.

IS professional orientation is also of importance to task innovation, as suggested in the previous section. Where the IS department is more professionally oriented than it is business oriented, it will be more motivated to do "good work" according to technical and professional norms, than it will be to simply improve upon the cost-effectiveness of its service. Innovation is often the stuff of such good work for the professional, who compares IS in his or her own department with IS elsewhere. Being at the "leading edge" is especially prized by IS professionals, who recognize the rapidity with which their expertise is subject to obsolescence (Bartol and Martin 1982). However, because the professionally-oriented IS unit may be only loosely coupled to the host organization business, its innovativeness may not extend to innovations involving core business technology, where key knowledge is especially likely to reside with users. Thus: (P4) Early adoption of an IS innovation of Type I or II is more likely where the IS unit is professionally oriented.

Nevertheless, all IS departments remain subject to the business orientations of their host organizations. Where such a business orientation does not involve IS in a strategic way, the IS department should expect to prosper according to the slack resources available overall, and innovation should vary accordingly. However, where the business of the host organization is involved fundamentally with IS expertise, innovation may be motivated in part for strategic reasons. IS may be recognized to contribute to core business technology and to competitive advantage or parity. Thus, for example, reservation systems have come to be recognized as fundamental to survival and success within the airline business, as described above. Here and elsewhere, IS innovation may be understood as necessary to market development, or the establishment of competitive advantage through product differentiation. Where the business of the host organization also markets IS resources, e.g., computer hardware or software, to its customers, IS innovation may further be understood as providing a customer model. It may also be encouraged where the business of the host organization involves significant IS costs and suggests a competitive advantage to be obtained through lower IS-cost production. Hence: (P5) Early adoption of an IS innovation of Type III is more likely where IS is of strategic importance to the host organization business.

Table 3 summarizes the hypothesized contingencies associated with IS innovation of all three types, considering whether IS is professionally or business oriented, and whether IS is strategic or not to the business. Type I and II innovators are hypothesized to be professionally-oriented, rather than business-oriented IS organizations. Type III innovators should be those for whom IS is strategic to the business. A differential interaction effect is further hypothesized: where IS is professionally oriented, Type I and II innovation may be greater where IS is also strategic to the business; this is because the strong-order effects of Type III innovation are likely to compel certain Type I and II innovation. However, where IS is strategic to the business, Type III innovation may be greater where IS is business oriented, rather than professionally oriented; this is because users of IS products and services imbedded in core business technology are very likely to be the important sources

Table 3 IS Innovation Contingencies

	IS Strategic to Business	IS Not Strategic to Business
IS Professionally Oriented	Type I, II, III Innovation	Type I, II Innovation
IS Business Oriented	Type III Innovation	No Innovation

Note. An interaction effect is also suggested. Type I and II innovation is posited to be greater where IS is professionally oriented and IS is also strategic to the business, Type III innovation is posited to be greater where IS is business oriented and IS is also strategic to the business.

of the innovation (see von Hippel 1988). On the whole, therefore, we conjecture that neither a professional orientation nor a business orientation dominates the other in support of IS innovation.

The Evolution of IS Innovations

Because an innovation may always be improved upon, because continued adoption is also informative and adaptive, and because of the phenomenon of organizational lag described above, IS innovations are themselves likely to evolve over the time period in which they are successively adopted. Such evolution has received comparatively little attention in the innovation literature, even though innovations are known to be frequently "re-invented" during their implementation (March 1981, Rogers 1983). To date, most innovation studies have employed diffusion models which take the nature and identity of the innovation for granted (Tornatsky and Fleischer 1990). Here we propose instead that the features of an IS innovation are not fixed, but rather continue to develop over time, with significant organizational implications.

First, diffusion of an IS innovation takes place over some time period during which other, still newer developments in the professional and business environments take place. These developments seed additional innovations, as well as shape the evolution of earlier innovations still underway. New technological developments, as illustrated, for example, by the advent of microcomputing, computer networks, computer-aided vision and robotics, and expert system methods, are particularly influential. As they continue to cascade one upon another into the professional and business environments over a relatively short period of time, their consequences for IS innovation tend understandably to be profound. IS innovations are in effect often substantially reconfigured and redefined over the period of their institutionalization, as with the information center, as we discuss below; they may even be subsumed under another innovative concept, as with the various innovations which now comprise CIM. Thus, in a variety of ways: (P6) An IS innovation is likely to evolve such that it is increasingly tailored (or even transformed) by means of new features which accommodate the adoption of newer, related innovations.

Three forms of organizational lag (Evan 1966, Damanpour and Evan 1984) should also be reflected in the evolution of an IS innovation. First, work organizational features should lag information technological features. New developments in the latter often provide the impetus for the former. Indeed, work organizational features are often created to "absorb" information technology features, i.e. render them useful within the organization. The trialability of the predominately technical innovation often makes the need for such work organizational features apparent. Thus, innovative application software may be acquired and "pilot tested" for an extended period before work is eventually reorganized around it, for example. Early adopters are apt to carry the heaviest burden; their hard-learned lessons can be packaged and transmitted to later adopters as new organizational features. Operating systems for computers, acquired by first and early adopters before the job of systems programming was developed, provide another good example. The case of database management systems and data administration is also illustrative, as we shall discuss later. Thus: (P7) An IS innovation is likely to evolve such that new work organizational features absorb information technology features.

An IS innovation should further evolve in the broader institutional context of its successive adoption. To the extent that an innovation is adopted first by more professionally oriented IS organizations, and later by more business oriented IS organizations, as hypothesized above, it should similarly be repackaged over time, reflecting a second form of organizational lag. Increasingly, the business benefits of the innovation should be emphasized, as its advocates push and gain wider acceptance. As one example, DBMS are now widely diffused and understood to provide important business advantages in information management, while they were originally adopted for narrower technical reasons. As another example, CASE (Computer-Assisted Software Engineering) is not yet widely diffused; the logic for its adoption remains primarily technical and professional. While business advantages for CASE are sometimes claimed, they are not yet widely believed. Thus, in the case of Type I and II innovations, the business rationale for the innovation should lag the professional rationale. Indeed the emergence of a generally accepted business rationale may signal the institutionalization of the innovation (Meyer and Rowan 1977). Summariz-

ing: (P8) An IS innovation of Type I or II is likely to evolve such that it is based increasingly on a business rationale, more than a professional rationale.

In the special case of Type III innovations, business administrative features should also lag core technology features. Here, general management information system (MIS) features are likely to be built upon already established operational foundations. Thus, for example, cost accounting must be tailored to operations associated with a new product's manufacture. A periodic management report may aggregate from an accumulated history of detailed data associated with an automated production process. Indeed, the eventual penetration of the management hierarchy may be conceived as part of the innovation itself, as with MRP, as we discuss later. Thus: (P9) An IS innovation of Type III is likely to evolve such that it increasingly serves the administrative, as well as the technical, core of the business.

Finally, in the case of Type II and III innovations comprising IS products and services supported by application software in particular, these innovations will tend to be increasingly elaborated with additional business functionality among their features, as users continue to identify new needs which may be met by various enhancements and extensions. Indeed, installed application software tends to grow through enhancements and extensions at a rate of about 10% per year (Lientz and Swanson 1980). While most such modifications are no doubt local to their particular installation, certain of them are likely to diffuse among other adopters of the innovation and eventually be institutionalized as part of the innovation itself. Innovation and evolution are thus continuous, as one good use begets another. Thus: (P10) An IS innovation of Type II or III is likely to evolve such that it is increasingly elaborated with additional business functionality among its features.

In summary, the evolution of an IS innovation is likely to mirror the pattern of its adoption and diffusion among IS organizations over time. As adoption becomes more widespread, the conception of the innovation should become more organizational. The business rationale supporting adoption should become better articulated. IS products and services should incorporate more substantial business functionality. The administrative core should be better served. Whether later adopters therefore more easily assimilate these more organizational innovations is among the questions in need of research.

Summary

IS innovations can be typed to relate them to organizational innovation more broadly. While Type I innovations are confined to IS itself, Types II and III are directed toward the administrative and technical cores of the business. The IS unit itself is linked both to its host organization and to its professional environment. Because it is likely to be tightly coupled to one only where it is loosely coupled to the other, IS may tend to be either business oriented or professionally oriented. While implications for innovation adoption and diffusion differ across innovation types, neither a business nor a professional orientation dominates the other as an overall basis for innovation. Beyond adoption, IS innovations also evolve as they diffuse among organizations, and their feature mixes are likely to exhibit several forms of organizational lag. Again, significant differences in innovation evolution are expected among innovation types. Table 4 presents an overall propositional summary.

Illustrative IS Innovations

We further illustrate and examine our theoretical foundations by drawing from existing research findings on IS innovations of the three suggested types. The case of data administration as an example of a Type I innovation is considered first. The case of the information center (IC), considered a Type II innovation, follows. A discussion of material requirements planning (MRP) as an illustration of a Type III innovation concludes. While our propositions on innovation diffusion and evolution are explored in each case, we do not aim at drawing confirmatory conclusions as such. Rather we seek to add depth to our analysis and to surface additional issues and insights.

Data Administration

We draw principally here from Hsieh's (1987) survey of the adoption of data administration among 42 Fortune 500 companies with headquarters or major operations in California. Additional background comes from an earlier survey by Kahn (1983) and from Gillenson (1985).

Table 4 Propositional Summary and Illustrative Research

Propositions	Illustrative Research
Early adoption of an IS innovation is more likely.	
1 Where the IS unit is large and diversified (Type I); Where the host organization is large and diversified (Type II or III)	Qualified support (Fuller and Swanson 1992a; Anderson 1980, 1981); Related findings (Hsieh 1987)
2 Where the IS unit possesses slack resources (Type I); Where the host organization possesses slack resources (Type II or III)	Related findings (Hsieh 1987); Not supported (Fuller and Swanson 1992a); No evidence (Anderson 1980, 1981)
3 Where the IS unit has a large but not aged application system portfolio (Type II or III)	No evidence (Fuller and Swanson 1992a; Anderson 1980, 1981)
4 Where the IS unit is professionally oriented (Type I or II)	Qualified support (Fuller and Swanson 1992a); Not supported (Hsieh 1987)
5 Where IS is strategic to the host organization business (Type III)	Not supported (Anderson 1980, 1981)
An IS innovation is likely to evolve such that:	
6 It is increasingly tailored (or even transformed) by means of new features which accommodate the adoption of newer, related innovations	Related findings (Hsieh 1987, Fuller and Swanson, 1992b; Anderson 1980, 1981)
7 New work organizational features absorb information technology features	Qualified support (Hsieh 1987; Anderson 1980, 1981); Related findings (Fuller and Swanson 1992b)
8 It is based increasingly on a business rationale, more than a professional rationale (Type I or II)	Not supported (Fuller and Swanson, 1992b); No evidence (Hsieh 1987)
9 It increasingly serves the administrative, as well as the technical, core of the business (Type III)	Qualified support (Anderson 1980, 1981)
10 It is increasingly elaborated with additional business functionality among its features (Type II or III)	Qualified support (Fuller and Swanson 1992b); Related findings (Anderson 1980, 1981)

Data administration is the function responsible for the control of IS's data resources. The concept originated in the mid-1970s, growing out of basic developments in database technology in the late 1960s. It is an example of a Type I(b) innovation, being mostly concerned with IS's internal organization and control of its data (Kahn 1983), and thus principally confined to the domain of IS work technology (McCririck and Goldstein 1980). Implications for IS products and services are indirect, more than direct. Still, the DA function provides a new point of contact for business users with data problems and is often charged with identifying data sharing opportunities and developing strategic plans for data use (Kahn 1983). Important weak-order effects of data administration upon business innovation beyond the confines of IS are identifiable.

Data administration also illustrates well the phenomenon of organizational lag. Innovators in data administration were those who began by acquiring database management systems (DBMSs) and only belatedly discovered the need to assimilate them organizationally. Kahn (1983) observes, "Often the DBMS did not solve the enterprise's data management problems, and, in fact, created new ones" (p. 797). Data administration thus evolved as a concept from what began as a primarily technological concern. In this case, the adoption of the technological innovation gave seed to an essentially new, organizational innovation.

Over time, however, as the concept diffused among IS organizations, it became increasingly accepted as professional wisdom that a data administration function should be established before a DBMS is acquired, not after. Consistent with this precept, Hsieh finds that later adopters of data administration are more likely to have adhered to it, than were their predecessors.

Hsieh also finds that innovators in data administration were associated with relatively greater host organizational size and slack (as indicated by number of employees, revenues, profits in the organization and in the industry). Data on IS unit size are not reported. Innovators were not associated with host organizations in information service industries (banking, finance, and

insurance) more than other industries, however, contrary to her original expectations.

Why would IS units in these industries not be the innovators in data administration? Because data administration is a Type I innovation, with only weak strategic implications for the business, innovators should be those who are professionally oriented, whatever the business supported. While Hsieh's data unfortunately include no measures of professional orientation, representative salary data for IS personnel across industries, obtained from other sources (Hodges 1987, Ludlum 1988) suggest that data administrators in banking and financial services (though not in insurance) receive significantly higher compensation, on average, than do their counterparts elsewhere. Hence, to the extent that salary level reflects professional orientation, in terms of mobile staff with superior, higher-priced skills, data administration in the information service industries may indeed be somewhat more professionally oriented than in other industries. Hsieh's nonfindings remain a puzzle (which may, however, be attributable to the relatively small sample of firms, only 13 of which were in the information service industries).

Overall, the most interesting insight which emerges here pertains to our propositions that an IS innovation is likely to evolve over time such that it is increasingly tailored to the concurrent adoption of other related innovations, and such that its work organizational features are increasingly prominent. In the case of data administration, we do not see precisely this. Rather we observe another variant of the organizational lag phenomenon. We see that data administration has developed in response to the adoption and evolution of a primarily technological innovation (DBMS), emerging as a distinct work organizational innovation in its own right. Thus, technological innovations may not only evolve so as to be absorbed by organizational features, they may also seed the origin of entirely new organizational innovations.

The Information Center

We draw principally here from recent research by Fuller and Swanson (1992a, 1992b), who report on the adoption of the information center (IC) concept among 62 organizations. We draw too from a comparable survey of 596 IS managers undertaken by the American Management Association (AMA), reported by Bohl (1986).

The IC concept originated in the mid 1970s within IBM (Hammond 1982), motivated by the burgeoning backlog of work faced by many IS units. Its purpose was to exploit new technology, particularly fourth-generation languages, to enable users to access online data themselves, freeing IS staff for other tasks (Sprague and McNurlin 1986). The IC provided a specialized IS unit where users could obtain tools, training, and support for this purpose.

The nature of the IC was, however, soon transformed by the advent of the personal computer. End user computing (EUC) quickly spread, and the IC assumed the new role of its facilitation and control from the viewpoint of IS.

The IC is probably best considered a Type II innovation. It provides new IS services to a business. These services are not usually directed toward support of the technical core; rather they are typically aimed more broadly at support of the administrative infrastructure (Laudon and Laudon 1991).

Diffusion of the IC concept has been extremely rap among businesses. The AMA survey reports 80% large organizations to have established ICs as of 1984, up from 67% the previous year (Rhodes 1985).

Fuller and Swanson (1992a), from their recent research, find that IS staff size and host organization size (all locations) distinguish between IC adopters and non-adopters, although not between early and later adoption, contrary to original expectations. Education level of the IS staff, a measure of its professional orientation, similarly distinguishes between adopters and non-adopters, although not between early and late adoption. IC adopters thus tend to be the larger, more professionally oriented organizations.

In contrast, the business industry supported fails to distinguish between IC adopters and non-adopters, although it does distinguish early from later adoption. Among IC adopters, early adoption is significantly represented among certain information intensive industries (aerospace, banking, electronics, financial, and insurance), where IS is likely to be strategic. In explaining these findings, Fuller and Swanson conjecture that supply-oriented factors (e.g., size and professionalism)

may establish the pre-conditions for adoption, while demand-oriented factors (e.g., strategic need) may motivate early adoption where pre-conditions are met.

Why might strategic need play a role here, if the IC is a Type II rather than a Type III innovation? One possibility is that the IC promises to free new applications from the IS work backlog. Where the backlog includes Type III innovations, the IC indirectly addresses a strategic need. This raises the issue of interactions among different innovation types in explaining their adoption and diffusion. Synergy is one such interaction (Fennel 1984). Such interactions pose obvious complications for our propositions.

Fuller and Swanson (1992b) further find that the services provided by an IC tend to elaborate over time. They find no pattern of service which distinguishes between early and late adopters. Nor do they find the rationale for adoption to be significantly correlated with time of adoption. However, they do find evidence that ICs may be evolving so as to give new emphasis to the establishment of hardware and software standards and new security practices, and relatively less emphasis to their original education and training mission, consistent with the recommendation of Henderson and Treacy (1986).

In summary, the case of information centers suggests significant new insights. Most importantly, it raises the issue of explaining nonadoption, as opposed to late adoption, of IS and other innovations. Current innovation theory speaks little, if at all, to this issue (Abrahamson 1991). In addition, the IC case suggests that interactions among IS innovations may explain in part their adoption and diffusion among organizations. It may therefore be necessary to study IS innovations not just individually, but as ensembles.

Material Requirements Planning (MRP) Systems

We draw here from the results of a large-scale survey undertaken by Anderson et al. (1981, 1982) on behalf of the American Production and Inventory Control Society (APICS), which reports on the adoption and implementation of material requirements planning (MRP) systems among 679 firms.

MRP exemplifies the Type III innovation. It provides basic support of a manufacturing process and is thus embedded in the core technology of the business. Narrowly conceived, it involves the parts explosion process (the translation of orders for final products into orders for their component parts). More broadly, it incorporates aspects of capacity planning, purchasing, shop floor control, costing, and various other coordinative functions. Its level of penetration has been characterized as ranging upward from Class D ("exists mainly in data processing") to Class A ("closed loop system for both priority and capacity planning"). Not surprisingly, as penetration increases within an adopting firm, the MRP concept itself is found to broaden within the organization. It becomes increasingly managerial, less purely technical.

First use of the MRP approach among respondents to the APICS survey occurred in the late 1950s, and subsequent adoption followed an exponential growth pattern into the late 1970s. Sixty-four percent of the APICS survey respondents had adopted MRP as of 1978 (which is probably an overestimate of the adoption percentage in the sample population as a whole).

Early adopters of MRP among the respondents tended to be the larger companies. Later adopters include an increasing proportion of smaller companies, as requisite computer hardware and software have become more affordable. Early adopters are also most likely to now be a Class A user and to have more extensively computerized MRP system elements. However, the use of certain technical MRP features is apparently unrelated to length of experience with MRP.

Extent of use of MRP varies somewhat across those industries which employ it (leading users include the electric-electronic instruments and transportation equipment industries). However, no significant differences among industries distinguish early from later MRP adopters.

When asked to assess MRP benefits, managers indicated that production scheduling and inventory control were substantially improved, with inventory turnover increased by 34%, average delivery leadtimes reduced by 17%, percent of time meeting delivery promises increased by 24%, and number of expeditors decreased by 41%, on average. They also felt, however, that despite these improvements, MRP had little impact to date upon the firm's competitive position. A very likely in-

terpretation, in this case, is that MRP has become substantially institutionalized among manufacturing organizations, and that no recognizable competitive advantage, only parity, is now to be achieved through its adoption. Among those who still have not adopted MRP, many are likely to be organizations for whom MRP offers a comparatively poor task fit (Cooper and Zmud 1990).

Summarizing in the case of MRP, the most interesting insight pertains to its conceptual evolution. As expected, MRP has evolved to incorporate an increasing proportion of organizational features, and to increasingly serve the administrative, in addition to the technical core of the business. However, this evolution apparently follows not simply from the successive adoption of the innovation among organizations, but rather from its gradual and cumulative penetration of the overall business once adopted. The process of penetration of IS innovations within and among businesses therefore impacts upon the overall diffusion and evolution process and must also be incorporated in future theory development. Studies of secondary adoption may have an important role to play here, beyond their usual focus on local implementation problems.

Summary

While our propositions on IS innovation diffusion and evolution are only selectively supported by findings from existing studies of data administration, information centers, and materials requirements planning, our preliminary foundations as a whole are shown to be promising for examining IS innovations across a significant range of types. Table 4 summarizes for the reader's convenience. Our additional insights, discussed above, point principally toward needed theoretical refinement, elaboration, and extension. The foundations thus offer ample motivation for further development and research. Among our conclusions, we indicate some likely directions.

Conclusion

Since Leavitt and Whisler (1958) speculated more than three decades ago on the long-term impact of computerization on management, organizational scholars have debated among themselves and failed to reach a consensus on the importance of information technology to their discipline (see, e.g. Goodman et al. 1990). In the meantime, information systems (IS) have accumulated in organizations and penetrated to almost all corners of the enterprise. Growth continues unabated. New investment in information technology now comprises about 50% of all new U.S. capital investment (Kriebel 1988).

We suggest here that innovation theory offers an especially promising route for developing our understanding of the relationship of IS to the larger business. And in this paper we have taken some first steps in this direction. Basic concepts and theory of organizational innovation in general have been applied in laying the foundations for a theory of IS innovation in particular. These foundations include a proposed typology of IS innovation which is specifically and inclusively related to overall business innovation; they further include a posited contextual structure for IS innovation diffusion among organizations which further ties IS to the larger business and its environment; and, finally, they include a variety of specific propositions about the pattern of IS innovation adoption, diffusion, and evolution. Three specific innovations—data administration, the information center (IC), and material requirements planning (MRP)—are examined in terms of these foundations.

The implications of the present work also extend to other innovation domains. As discussed above, traditional views of organizational innovation have distinguished process from product innovation, and have further differentiated between administrative and technological process innovation. To date, however, they have not provided a useful structure for understanding the contributions of professional organizational subunits to the overall innovation process. In the case of IS this is especially unfortunate because, as we have seen, IS is likely to impact upon all aspects of business innovation. However, the contributions of other professional sub-units to organizational innovation may similarly deserve research attention. Teece (1987) gives recent reconsideration to the obvious case of research and development sub-units; Chandler (1977) offers an insightful review of the development of the management accounting function and its influence on the rise of the modern corporate form.

In the case of the IS professional sub-unit, much remains to be learned about its innovations and their contributions to the organization. While more studies of IS innovations of all kinds should be helpful, studies of Type II and III innovations are especially needed to address the tie of IS to the larger organization. Here, we have posited differential contingencies for adoption and diffusion. It remains to confirm whether this differential exists as suggested, and, if so, to understand more fully its ramifications. It also remains to confirm whether the phenomenon of organizational lag operates as we have speculated, and, if so, to understand the implications for assimilation among later adopters.

It further remains to understand other aspects of IS innovation not explored here. Identifying the sources of IS innovation may be particularly fruitful, for example. Von Hippel (1988) shows that for certain classes of industrial products, users are often the original source of innovation, i.e. the inventors. Similarly, in the case of IS, it might be suggested that the users of certain, say Type III, innovations may also be their inventive source, for comparable reasons. The mediating role of external parties such as consultants, vendors, and providers of outsourced services also needs further study as suggested by Attewell (1992).

In the case of traditional adoption and diffusion studies, the study of innovation hold-outs, or nonadopters, should be particularly informative (see, e.g., Abrahamson 1991). The institutionalization of an IS innovation does not imply that it will be universally adopted. Those organizations which choose not to adopt may do so for reasons comparable to those which motivated early adopters. Their choice may be more consciously rational than imitative.[17] Among adopters, implementation and organizational penetration also deserve closer investigation. Here it will be especially interesting to know how implementation problems and rate of penetration vary between early and later adopters, for example. This in turn may inform the organizational lag question.

Similarly, the adoption and diffusion of various IS innovations should probably also be studied collectively. Complementarities among many innovations appear to be even more important in adoption and implementation than we first suspected. Much might be learned, therefore, by focusing upon the origins and establishment of innovation bundles among organizations, such as those represented by CIM, for example.

The forms of research needed to address these issues may well be much like those needed for the study of organizational communities, in general. Here three fundamentals are espoused (Scott 1990): (1) the use of a high level of analysis that encompasses diverse types of interrelated organizations (the potential adopters of the innovation, as well as other institutional participants such as vendors and consultants); (2) the study of change processes over relatively long time periods (sufficient to observe and document the diffusion and institutionalization process); and (3) the giving of careful attention to the institutional arrangements that support and constrain the technological processes (as with the innovation diffusion circuit postulated here).

In the long run, IS innovation research along these lines should be helpful to practicing managers in several ways. First, and most important, a more refined understanding of the innovative role of IS within the larger organization should be gained. Second, the consequences of professional versus business orientations of IS units should be better understood, enabling managers to better position and shape these units consistent with expectations for innovation. Third, knowledge of the evolution of IS innovations should enable management to better ascertain when it is good to be among those who lead, and when, in contrast, it is good to be among those who follow, learning from the accumulated experience of their predecessors.[18]

[17] We are grateful to Cliff Nass for his suggestion on this point.

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