The Assimilation of Knowledge Platforms in Organizations: An Empirical Investigation

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Abstract
The ability to integrate dispersed pockets of expertise and institute an organizational repository of knowledge is considered to be vital for sustained effectiveness in contemporary business environments. Information technologies provide cost-effective functionalities for building knowledge platforms through systematic acquisition, storage, and dissemination of organizational knowledge. However, in order to gain the value-adding potential of organizational knowledge, it is not sufficient to simply adopt and deploy IT-enabled knowledge platforms. These platforms must be assimilated into the ongoing work processes in organizations. Yet, theories of technology innovation and use suggest that a variety of institutional, social, and political factors blend together in influencing the extent to which complex information technologies are actually assimilated into organizational practice. Therefore, this research addresses a significant question: What forces influence the assimilation of knowledge platforms in organization? Given the significant gap between the adoption and actual assimilation of complex technologies into organizations, this is an important question. Empirical evidence is generated by examining the forces influencing the assimilation of CASE technologies in systems development projects in organizations. CASE is considered to be one of the most mature knowledge platforms in contemporary organizations. The empirical evidence sheds light on the role of institutional forces that influence the rate of assimilation of the technology. The findings have significant implications for further research and practice.
(*Knowledge Management*; *Technology Assimilation*; *Institutional Theories*)

Introduction
Contemporary perspectives on organizations increasingly frame organizations as architectures for integrating knowledge such that it can be deployed in ongoing work activities for delivering business value (March 1991, Spender 1992, Grant 1996a). These perspectives acknowledge that ‘‘pockets’’ of specialized knowledge exist, but they tend to be spatially and temporally dispersed across firms because they are constituted and generated in the course of practice and reflection by individuals working on specific projects, products, or processes in different locations at different times. Therefore, organizational effectiveness is linked with a firm’s ability to integrate these dispersed pockets of knowledge such that they become generally available for ongoing work throughout the firm (Kogut and Zander 1996). Knowledge platforms, built largely through the cost-effective functionalities of advanced information technologies, are seen as an important organizational mechanism for enabling the systematic acquisition, storage, and dissemination of organizational knowledge (Huber 1990). They are expected to play a significant role in enhancing the combinative capacity of firms (Kogut and Zander 1992).

However, in order to gain the value-adding potential of organizational knowledge, it is not sufficient to simply adopt and deploy IT-enabled knowledge platforms. Significant business value will only be derived from these knowledge platforms when their implicit functionality is assimilated within the ongoing actions of individuals and teams. However, the assimilation of complex technologies is never easy. Theories of technological innovation make it quite clear that potential adopters are likely to experience considerable ambiguity about the value of such technologies for their work (Weick 1990). This becomes particularly vexing with more generic and intrusive technologies, ultimately producing doubts or even misgivings among potential adopters regarding the technology’s perceived benefits and costs. As a consequence,

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a myriad of institutional, social, and political forces blend together to influence how potential adopters make sense out of the technology and, accordingly, assimilate its use (Rogers 1983, Tornatzky and Fleischer 1990). As but one example, Cooper and Zmud (1990) and Leonard-Barton and Deschamps (1988) found that senior management serves a crucial role in influencing how users perceive the potential value of a technology being introduced into their work domains.

This research examines how institutional factors influence the assimilation of IT-enabled knowledge platforms in organizations. Specifically, we examine factors that affect the use of CASE technologies as a knowledge platform for systems development work activities in organizations. We regard CASE technologies to be among the most mature knowledge-platform technologies in use. Though generally acknowledged to possess a significant potential for accelerating the productivity of systems development activities in organizations (Dixon 1992, Feuche 1989, Forte and Norman 1992, Martin 1989), empirical research suggests that CASE technology has experienced low rates of organizational assimilation (Martin 1995, Rai 1995, Rai and Howard 1993). For example, Kemerer (1992) observed that, within a year of CASE being adopted, 70% of the adopting organizations did not use the technology and 25% used it only on a limited basis.

One explanation for this low rate of organizational assimilation might be the realization that the primary value of CASE technology lies in its role as a knowledge platform, not as a means for automating systems development activities. The CASE repository is a database where relevant systems development knowledge can be stored, manipulated, and retrieved, so that this knowledge can be integrated and used in an organization's ongoing stream of systems development activities across different locations and over time (Martin 1990a; 1990b; McClure 1989). Yourdon (1992) calls the repository the ''single most important technological development in the CASE industry . . . today's CASE environment could be regarded as a number of tools clustered around the repository'' (p. 137). The value of the repository in facilitating the knowledge-platform-enabling role of CASE becomes clear since ''. . . knowledge is the raw material of software design teams'' (Walz et al. 1993, p. 63). The CASE repository provides a means for codifying and storing relevant systems development knowledge and acts as an organizational memory. In doing so, the repository is expected to enhance the value of CASE technologies for ongoing systems development activities (McClure 1992).

Therefore, this research examines the role of institutional influences in the organizational assimilation of CASE technology, specifically from the perspective of the CASE as an IT-enabled knowledge platform. The next section of this paper presents the conceptual background for this research. Next, the conceptual model for this research is introduced and different hypotheses are presented to explain the relationships depicted within this model. The subsequent section describes the research methodology. Next, we describe the analysis strategy and the results of the hypothesis testing. Finally, the paper discusses the implications of this research for further research and practice.

Conceptual Background

Three streams of literature yield key insights regarding the assimilation of IT-enabled knowledge platforms: knowledge-based views of the firm, the role of institutional forces on individual technology use, and the assimilation of IT within organizations. Each of these literature streams is discussed in the following sections.

Knowledge-Based Views of the Firm

Knowledge-based theories of the firm advocate that firms are organized to accomplish two distinct goals: the generation of knowledge and the application of knowledge (Demsetz 1991, Spender 1996, Grant 1996a). Individuals, teams, and departments generate knowledge within a firm as they process information, make decisions, and act on existing knowledge. Knowledge is created in two distinct forms: explicit and tacit (Polanyi 1962, Nonaka and Takeuchi 1995, Nelson and Winter 1982, Spender 1992). Explicit knowledge is easy to communicate and transfer because it can be codified. On the contrary, tacit knowledge is more difficult to transfer and communicate because it is inextricably woven with the experiences and situational contexts within which it was generated. Nonaka and Takeuchi (1995) utilize this distinction to propose ''organizational knowledge is created and expanded through social interaction between tacit knowledge and explicit knowledge'' (p. 61). Their theory of organizational knowledge creation revolves around an interaction between two dimensions: conversions from tacit to explicit knowledge and vice versa; and transfers between individual, group, organizational, and interorganizational levels. One of the significant characteristics of the knowledge creation process is that it occurs most efficiently and effectively through specialization and differentiation, i.e., individuals or teams with specific expertise generate distinct slices of organizational knowledge.

Firms provide not only forums for the generation of knowledge but also for the integration and application of existing knowledge in ongoing business activities and work processes. As Grant (1996a) states:

> Integration of specialist knowledge to perform a discrete productive task is the essence of organizational capability, defined as a firm's ability to perform repeatedly a productive task which relates either directly or indirectly to a firm's capacity for creating value through effecting the transformation of inputs into outputs (p. 377).

The existing literature categorizes mechanisms for knowledge integration into four distinct categories. The first category of mechanisms involves the use of rules and directives, whereby tacit knowledge is codified into explicit instructions (Demsetz 1991, Grant 1996a, 1996b). A second category of mechanisms involves incorporating refined knowledge (tacit and explicit) into the sequencing of production rules associated with work processes. A third category focuses on the development of routines that coordinate the work-related efforts of professionals and experts in an organization (Nelson and Winter 1982, Grant 1996b). Routines facilitate knowledge integration in two ways: They habituate automated or practiced patterns of interaction and hence allow for the integration of knowledge required for task performance (Gersick and Hackman 1990, Weick and Roberts 1993), and they allow the improvisation of a varied repertoire of interactions as individuals confront the tasks facing them (Pentland and Reuter 1994). A final category of mechanisms for knowledge integration lies with the use of teams and meetings (Van de Ven et al. 1976).

Extending these ideas, we propose that knowledge platforms enhance firms' knowledge integration capability by complementing and supplementing the effectiveness of all of the above tactics. Knowledge platforms provide a repository of codified knowledge and act as an organizational memory (Walsh and Ungson 1991). The knowledge stored and maintained in these platforms can be used in conjunction with rules and procedures or with organizational routines for utilizing knowledge in ongoing work processes. Similarly, the knowledge contained in these platforms can be used in conjunction with the sequencing tactic, whereby various stages of the work-process activities utilize different slices or combinations of the knowledge stored in the knowledge repository. Finally, the knowledge repository enables teams of experts to draw upon and expand on the knowledge as they undertake work tasks.

Consider the role of CASE technology being applied to systems development work activities, the knowledge platform of interest in this study. The repository available in the CASE technology is a centralized database for storing knowledge needed to create, modify, and evolve applications systems in organizations (Tannenbaum 1994). The repository consists of two segments: an information repository and a data dictionary (Hoffer et al. 1996). The information repository contains a plethora of information about an organization's business, its applications portfolio, and its systems development practices, as well as reusable software assets (designs, templates, code, etc.). In addition, it provides automated tools to manage and control access to the repository's contents (Bruce et al. 1989). The data dictionary is a software tool used to codify the information repository. It provides facilities for recording, storing, organizing, and processing descriptions of the repository's contents (Lefkovitz 1985).

What types of systems development knowledge does the CASE repository store? As a knowledge-intensive work process, the systems development process includes planning, analysis, design, construction, and maintenance activities (Martin 1989, 1990a, Hackathorn and Karimi 1988, McClure 1992). As a knowledge platform, the CASE repository provides mechanisms for the codification, storage, and retrieval of knowledge assets associated with each of these activities (see Table 1).

However, systems development work processes do not rely on a CASE technology alone. Inevitably, most organizations also use a systems development *methodology* as a companion to the CASE technology (Hackathorn and Karimi 1988, Hoffer et al. 1996, Martin 1990a, Tannenbaum 1994, Vessey et al. 1992). A methodology is ''a coordinated group of applicable techniques, tasks, and guidelines designed to capture essential business and systems design knowledge and translate this information into an effective computer-based system'' (Dixon 1992, p. 97). A systems development methodology can and should be viewed as a complementary knowledge-integration mechanism that provides formal rules and guidelines and otherwise directs systems development activities.

Systems development methodologies not only operate as directives to systems developers, but they also sequence the development work process and allow experts (business analysts, systems designers, and programmers) to apply their knowledge at different stages of the development process. Most systems development methodologies sequence the systems development process into planning, analysis, design, construction, and maintenance activities and identify the appropriate work activities within each phase.

As this discussion illustrates, the CASE technology and the systems development methodology operate together in guiding knowledge-integration activities in systems development processes. Though our primary focus is upon the assimilation of CASE as a knowledge platform in systems development work processes, it is clear that we must account for the influence of the systems development

Table 1 Potential Dimensions of Knowledge Embeddedness[a]

Information Systems Planning

This phase is concerned with top management goals and critical success factors, and how technology can be used to create new opportunities or competitive advantages. A high-level overview is created of the enterprise, its functions, data, and information needs. The CASE repository stores knowledge on:

- Enterprise mission, objectives, and goals
- Critical success factors
- Market factors
- Organizational structure
- Enterprise data model
- Business processes
- Current information systems portfolios
- Business policies, rules, and events

Business Analysis

This phase is concerned with what processes are needed to run a selected business area, how these processes interrelate, and what data is needed. The repository can store knowledge on:

- Data models including entities and their relationships
- Attributes of each entity
- Process activity models
- Process decomposition diagrams
- Process dependency diagrams

Design

In this phase it is determined how selected processes in the business area are implemented in procedures and how these procedures work. Direct end-user involvement is needed in the design of the procedures. The repository can store knowledge on:

- Screen and report formats
- Data flow diagrams
- Module structure charts
- Module flow charts
- Action diagrams
- User interface specifications
- Data structure diagrams

Construction

Implementation of the procedures using, where practical, code generators and end-user tools. Design is linked to construction by means of prototyping. The repository can store knowledge on:

- Program structure charts
- Reusable code
- Physical database design and tables
- Stored record formats
- Test libraries and test cases

[a]Dixon 1992; IEF 1992; Martin 1990a, 1990b

methodology in understanding the extent of assimilation of CASE technology.

Institutional Theory

Institutional theory suggests that the behaviors of individuals within organizations are significantly influenced by the prevailing organizational norms, values, culture, and history. Different institutional structures, such as organizational routines, rules, regulations, and procedures are a microcosm of the institutional norms, values, and history and serve as powerful templates of action in guiding individual behavior. Scott (1995; see also, Orlikowski 1992) identifies three ways in which the institutional structures influence individual behavior:

1. Structures of signification, whereby the prevailing institutional structures yield meaning and understanding. Individuals draw upon these structures as cognitive guides to understand how they should conduct their behavior in novel work-process contexts.

2. Structures of legitimization, whereby the prevailing institutional structures validate specific behaviors as being appropriate in the organization and consistent with the goals and values of the organization. Individuals draw upon these structures as normative templates to reassure themselves about the organizational legitimacy of their actions.

3. Structures of domination, whereby the institutional structures regulate individual actions and behaviors. Individuals draw upon these structures to ensure that their actions do not violate institutional rules and to avoid being the target of organizational sanctions.

Extending these ideas, Orlikowski et al. (1995) suggest that two sets of actions characterize the dynamics of technology use in organizations: individual structuring actions and metastructuring actions. Each of these action sets is now explained in the context of technology assimilation.

The structuring actions of individual users explain their selective use of the features of a technology. When initially faced with the opportunity (or requirement) to apply a new technology in the conduct of their work, individuals often experience ambiguity regarding the value of the technology (Weick 1990). By invoking the prevailing institutional norms to shape their initial interpretations of the technology, these individuals orient their views of the technology toward specific features and functionalities (Orlikowski and Gash 1994, DeSanctis and Poole 1994). These users then engage in a series of explicit structuring actions for exploring if and how the technology "fits with" or "enhances" their work activities.

However, even as individual structuring actions determine their level of use of the technology, another set of organizational actions might operate to influence the individuals' structuring actions—metastructuring actions. Metastructuring actions are undertaken by the institutional elite (i.e., senior management) as well as technology champions, and they include both direct actions to make the technology more valuable to users and indirect actions to manipulate prevailing institutional structures and influence individual structuring actions. Examples of the latter type of metastructuring actions include the use of rewards and sanctions and visible, active advocacy of the technology by senior management.

These ideas have significant implications for our study. Prospective users of knowledge platforms are expected to orient their use behaviors within the institutional milieu of their organizations. Two metastructuring actions are of particular interest in this study. First, the extent to which the CASE repository has been populated with relevant knowledge should serve to enhance its value for ongoing systems development work activities. Second, active championing and advocacy of the CASE platform by senior management should serve to signal the importance of this technology. Indeed, empirical evidence regarding CASE assimilation does reveal that senior management championship has a significant influence on CASE usage (Rai and Howard 1994, Ilivari 1996).

Another significant implication of the institutional theory literature is related to the likely influence of an organization's systems development methodology on the assimilation of the CASE platform. Given that systems development methodologies are comprised of work rules, routines, and procedures, these devices have the potential to become entrenched institutional structures. Therefore, they could serve as powerful structures of signification for both the conduct of systems development work activities and the subsequent use of a complementary CASE platform (Beath and Orlikowski 1994, Orlikowski 1993). Systems designers and developers imbibed with an entrenched systems development methodology at the time of CASE adoption are likely to rely upon the methodology to structure their behaviors about CASE use. In other words, they will view the CASE platform as a ''methodology companion'' and only draw upon those CASE features that ''fit'' into the practices conditioned by this entrenched methodology. Tyre and Orlikowski (1994) present evidence that the existing systems development methodology significantly influenced how users perceived the value and role of CASE technologies and that, correspondingly, these users applied only those features that were consistent with their methodology-constrained views of the technology.

Theories of Technology Assimilation

Theories of technology assimilation have drawn attention to forces influencing the organizational use of complex technologies once they have been adopted in organizations. Assimilation is defined as the extent to which the use of the technology diffuses across the organizational projects or work processes and becomes routinized in the activities of those projects and processes (Tornatzky and Klein 1982, Cooper and Zmud 1990, Fichman and Kemerer 1997). The theories of technology assimilation agree that prospective users encounter significant challenges in learning about the technology and in understanding how they must reconceptualize their work-process activities in order to effectively use the technology (Saga and Zmud 1994, Attewell 1992, Fichman and Kemerer 1997). In the face of these challenges, users are more likely to use technologies that are perceived as: being easy to use, having a clear relative advantage over existing ways of doing work, being less complex, and being compatible with the existing work domain (Rogers 1983, Moore and Benbasat 1991).

Further, the successful use of a new technology often requires the mutual adaptation of the technology and the organizational context into which the technology is being introduced (Leonard-Barton 1988). As Van de Ven (1986) notes: ''innovations not only adapt to the existing organizational and industrial arrangements, but they also transform the structure and practice of these environments'' (p. 591). Therefore, actions by senior management or technology champions to unfreeze the prevailing institutional structures, introduce complementary structures to facilitate technology use, and reinforce norms that value the use of the technology are all likely to encourage the use of the technology (Kwon and Zmud 1987).

The theories of technology assimilation have significant implications for our study. First, we define the assimilation of the CASE knowledge platform as the proportion of an organization's systems development projects where the technology is being used to support systems development work activities. Significant knowledge barriers have been found to inhibit the use of CASE technologies in organizations (Fichman and Kemerer 1997). Therefore, actions that allow the reconceptualization of work processes, demonstrate the relative advantage and usefulness of the technology, and otherwise encourage and motivate a greater use of the CASE knowledge platform are all likely to stimulate greater assimilation.

Conceptual Model and Research Hypotheses

Figure 1 illustrates the conceptual research model for this examination of forces influencing the assimilation of CASE technology, where the CASE technology is viewed as a knowledge platform for facilitating systems development work activities. As expressed earlier, the assimilation of a CASE knowledge platform by an organization is defined as the proportion of the organization's systems development projects that substantively utilize the CASE platform. Higher levels of assimilation thus reflect the fact that a higher proportion of an organization's systems development project teams draw on the features and functionalities of the CASE platform.

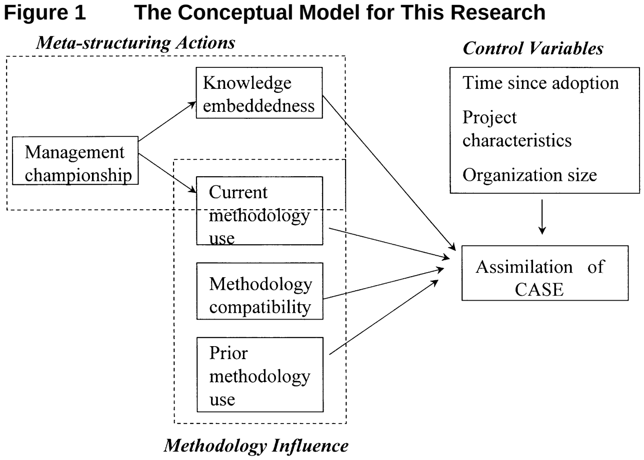
What influences the structuring actions of these project teams and, therefore, the degree of assimilation of the CASE knowledge platform? We had earlier identified two metastructuring actions: the extent of CASE repository knowledge embeddedness and the extent of senior management championship of the CASE initiative. Further, consistent with its role as a companion knowledge-integration mechanism, the system development methodology should have a significant influence on CASE. The different elements of our conceptual model are discussed below in greater detail.

Knowledge Embeddedness

Knowledge embeddedness refers to the extent to which relevant organizational knowledge has been codified and stored within the knowledge platform, i.e., the CASE repository. Table 1 illustrates the different types of systems development knowledge that are usually stored within the CASE repository (Hackathorn and Karimi 1988, Martin 1990a; 1990b, McClure 1992). Therefore, knowledge embeddedness refers to the extent to which these types of systems analysis and design knowledge—planning, analysis, design, or construction—are codified and stored in the CASE repository.

How does this knowledge come to be embedded within the CASE repository? Initially, the repository is established through actions taken to define the data dictionary and establish rules for codifying information about an enterprise's mission, strategies, business policies and procedures, and organizational structures (McClure 1992, Brown et al. 1994, Tannenbaum 1994). Subsequent use of the CASE knowledge platform on specific systems development projects creates knowledge-in-use as data sets, algorithms, work flows and processes, software designs, etc., are recognized, represented, and archived in the repository. Such knowledge-in-use requires substantial codification so that it can be stored within the repository and made accessible for use with subsequent systems development projects (Kogut and Zander 1992, Walsh and Ungson 1991). Clearly, the continued use of the CASE knowledge platform does add to repository and, hence, increases its knowledge embeddedness. However, without a data dictionary/directory, structures for codification, or a systematic process for building the repository as a knowledge platform, it is unlikely that the knowledge-in-use gained from successive systems development projects could be effectively codified and assimilated into the CASE repository (Tannenbaum 1994).

Figure 1 The Conceptual Model for This Research



The preceding discussion underscores two important aspects of our conceptual model. First, the organization-level initiatives taken to embed knowledge within the CASE repository represent metastructuring actions for promoting the use of CASE. Once populated, this repository becomes an important influence on the technology structuring actions of individual project team members. We anticipate that higher levels of knowledge embeddedness (i.e., where more of the organization's grammar, languages-in-action, and conventions have been captured within the repository), would enhance potential users' perceptions about the usefulness of CASE and its value as a source of knowledge for subsequent systems development projects (Davis et al. 1989).

On the other hand, the relationship between knowledge embeddedness and assimilation of CASE is likely to be somewhat recursive in nature. While knowledge embeddedness would promote greater assimilation, increased utilization of CASE across more and more projects would result in more of the relevant knowledge being codified and stored within the repository. However, this unfolding relationship would not occur without organization-level ''boot strapping'' efforts taken to initially and deliberately establish the repository. Therefore, we believe that knowledge embeddedness provides the initial impetus for enhanced levels of assimilation of CASE, as formally stated below:

HYPOTHESIS 1. *Higher levels of knowledge embeddedness will positively influence the assimilation of CASE knowledge platforms.*

Methodology Influence

Most successful knowledge platforms are inevitably accompanied by a work-process methodology that serves as a complementary knowledge-integration mechanism. While the knowledge platform provides both knowledge content and mechanisms for generating and accessing this content, a work-process methodology provides the directives, procedures, and templates to guide the retrieval, combination, and use of the knowledge content. In the CASE context, a systems development methodology provides the constitutive rules for systems development teams to interpret their work-process activities and to understand how the CASE repository could actively facilitate their systems development work activities (Beath and Orlikowski 1994, Orlikowski 1993). We offer two views of the dynamic processes by which the use of the methodology impacts the assimilation of CASE.

From an institutional theory perspective, methodology represents an entrenched institutional structure of signification: Systems development teams are expected to rely upon the methodology as a template for their work-process activities. The more entrenched a methodology is, the greater is its salience as a structure of signification. In particular, if a methodology is entrenched prior to the organizational adoption of the CASE knowledge platform, then that methodology becomes the ‘‘cognitive anchor’’ around which prospective users of the knowledge platform interpret the role of the platform, form attitudes and beliefs about its value, and structure their selective or complete use of the knowledge platform. An entrenched prior methodology conditions the frames of reference of prospective users and could be likely to inhibit users from developing an appreciation of the value and role of the CASE platform (Finlay and Mitchell 1994, Kemerer 1992). Prospective users are correspondingly less likely to reconceptualize their work processes, even though such reconceptualizations might facilitate greater use of the functionalities inherent in this new technology (Saga and Zmud 1994). Thus, it is anticipated that extensive *prior* methodology use would negatively influence the assimilation of CASE:

HYPOTHESIS 2. *Higher levels of prior methodology use will negatively influence the assimilation of CASE knowledge platforms.*

However, not all organizations that are adopting a CASE knowledge platform may experience these constraining institutional effects of prior methodology use. Many organizations either adopt a new methodology, or evolve their existing methodology, concurrent with their adoption of CASE (McClure 1989). In such instances, the methodology itself becomes a complementary innovation—it represents a vibrant element of the work-process changes introduced along with the CASE technology and influences the emergence of new sets of constitutive practices-in-use. Such actions represent the mutual adaptation dynamics that underlie the successful implementation of complex technologies into organizational work processes (Leonard-Barton 1988, Van de Ven 1986). The concurrent introduction of a new methodology along with a CASE platform is thus likely to impart a strong unfreezing effect in altering the prevailing structures of signification as project team members make decisions about their use of the CASE platform. Further, the continued use of the new methodology will be likely to reinforce the new structures of signification that users apply in their structuring actions relative to the CASE platform (McClure 1989, Orlikowski et al. 1995). Therefore, we hypothesize that the concurrent introduction of a methodology and greater levels of its use are likely to influence greater assimilation of CASE platforms.

HYPOTHESIS 3. *Higher levels of current methodology use will positively influence the assimilation of CASE knowledge platforms.*

Finally, the compatibility between the methodology and the CASE platform as complementary innovations that are introduced into the organization is likely to be another influence on the extent of CASE assimilation (Tornatzky and Klein 1982, Goodhue and Thompson 1995, McClure 1989, Vessey et al. 1992). When the current methodology is compatible with the CASE platform, users are able to develop an integrative perspective about the manner in which the two reinforce each other and support effective systems development practice (McClure 1989). This leads to the fourth hypothesis:

HYPOTHESIS 4. *Higher levels of methodology compatibility will positively influence the assimilation of the CASE platform.*

Management Championship

Management championship refers to the extent to which an organization’s senior management advocates the use of a technological innovation. High management championship would be said to exist where senior managers actively and openly champion the role of the CASE knowledge platform (Rai and Howard 1993). Management championship occurs through expressed mandates, reward systems and incentives, or through symbols that signal their commitment to the technology (Leonard-Barton and Deschamps 1988, Moore and Benbasat 1991). Management championship induces strong institutional norms and provides a political impetus for mobilizing commitment toward the technology innovation (Leonard-Barton and Deschamps 1988).

Instead of a direct impact on assimilation, our conceptual model hypothesizes that management championship has an indirect impact through its effects on knowledge embeddedness and concurrent methodology use. Management championship provides powerful structures of legitimation for the codification and storage of knowledge in the CASE repository. In many organizations, the efforts to codify knowledge and their storage within a knowledge platform for future use are less likely to occur voluntarily without significant management support (Goodman 1996). Therefore, we hypothesize that management championship will positively influence the knowledge embeddedness of the CASE platform.

HYPOTHESIS 5. *Higher levels of management championship will positively influence the knowledge embeddedness of the CASE platform.*

At the same time, management championship should also have a significant influence on the concurrent use of the methodology. Because the methodology is viewed as a complementary innovation and its structures are consonant to the structures of the CASE platform, management championship is likely to stimulate favorable perceptions and attitudes toward the methodology as well. Therefore, we hypothesize that:

HYPOTHESIS 6. *Higher levels of management championship will positively influence the level of current methodology use.*

Control Variables

In addition to the factors identified so far, prior research on innovation diffusion and infusion suggests a number of additional factors be considered because of their likely influence on the assimilation of CASE knowledge platforms.

Organizational Size. Larger organizations are more likely to be early adopters of technological innovations and possess sufficient resources to foster the adaptation and acceptance mechanisms required for greater levels of CASE assimilation (Tornatzsky and Fleischer 1990, Rogers 1983). Size is a surrogate measure of the several factors that influence utilization of innovations: total resources, slack resources, and organizational structure (Rogers 1983).

Time-Since-Adoption. Time-since-adoption reflects an organization's cumulative experience with a CASE platform. Organizations that have adopted CASE relatively early are likely to be farther along in their mutual adaptation and learning processes (such as populating the CASE repository and integrating the current methodology with the CASE tool) than are later adopting organizations. Further, time-since-adoption also captures the effects of the ''critical-mass'' phenomenon on CASE assimilation: With increased time-since-adoption, a greater likelihood exists that a critical mass of projects have adopted and used the technology. Once an organization has passed this critical-mass threshold, subsequent projects could use CASE solely due to a bandwagon effect or for critical-mass benefits, unrelated to either knowledge embeddedness or methodology influence (Markus 1987). Time-since-adoption thus serves a key role in ruling out rival explanations to the posited research model.

Project Characteristics. The size of the development projects typically undertaken by a systems development organization can impact the assimilation of CASE platforms. For complex technologies such as CASE, the rate of assimilation is expected to be lower than that for simple technologies (Tornatzky and Klein 1982). The use of complex technologies on complex tasks could aggravate this effect (Zmud 1984, Cooper and Zmud 1990). Large projects are fraught with uncertainty and equivocality, and can therefore be more complex in nature. Such characteristics can lengthen the learning curve for potential CASE users as they engage in the process of mutual adaptation, and thus negatively affect their acceptance and utilization of the technology.

Research Methodology

Data were gathered through a large-sample questionnaire survey employing a purposive sampling strategy. A purposive sampling strategy was utilized because it was necessary to identify respondents from organizations that had adopted a specific CASE platform and were actively using it for their systems development activities. More specifically, contact was made with the user groups of popular CASE products; two of these groups (the IEF and the Knowledgeware user groups) agreed to participate, and the first author made presentations at user group meetings to solicit participation in the research project. In addition to volunteers attracted through these meetings, user-group mailing lists were used to solicit additional respondents.

Potential respondents were mailed a copy of the survey instrument along with a cover letter from the user-group coordinator encouraging their participation. Respondents were guaranteed both confidentiality and access to the aggregated survey results. In total, 494 questionnaire surveys were distributed and 176 completed responses obtained. The response rate of 39% compares favorably with other studies of organizational phenomena. Of these responses, 124 were received from organizations that had used the IEF CASE platform.

Sixty-seven percent of the respondents were CASE or data administrators who had responsibility for the CASE repository and for its internal diffusion across the development projects. The remaining 33% were systems designers in smaller organizations without a formal CASE or data administrator position; in these smaller organizations, these systems designer respondents performed the tasks otherwise given to a CASE or data administrator. Overall, our selection of respondents was designed to ensure that we tapped responses from individuals who were assigned responsibility for the CASE platform and repository; these respondents are appropriate for the type of constructs employed in our conceptual model.

Construct Operationalization

Knowledge Embeddedness. Respondents were asked to characterize the extent to which different elements of systems development knowledge were stored within the CASE repository at their organization. Prior to the actual study, a pilot testing process was used to develop a set of items to operationalize the embeddedness construct. The process consisted of two overlapping activities: a literature review to identify the appropriate elements of systems development knowledge that could be stored within the CASE repositories (for example, Martin 1990a, 1990b, 1990c, Dixon 1992, Stone 1993); and in-depth exploratory interviews with five systems developers experienced with and knowledgeable about CASE. Seven CASE experts who were familiar with the specific CASE tools examined in this research reviewed the items generated through this process. They verified that the questionnaire items did capture the different elements of systems development knowledge that could be stored within the CASE repository of these two CASE products. Finally, the items were pilot tested with five developers at three nearby organizations that had implemented one of the CASE technologies of interest in this study. These participants completed the survey in the presence of the first author and explained how they interpreted the items; these sessions were used to establish and enhance the face validity of the items.

Through this process, a final set of thirty-two items representing the four different domains of knowledge embeddedness (planning, analysis, design, and construction) were presented to the respondents (see Appendix A). Using a 100 percent scale, respondents were asked to indicate the proportion of the relevant organizational information that was being stored within the CASE repository. Thus, for example, one of the items asked respondents to indicate what proportion of their organization's enterprise mission, objectives, and goals was being stored within the CASE repository.

Confirmatory factor analysis was used to verify that our operational items captured the specific dimensions of knowledge embeddedness. The following measurement properties are considered minimally important for demonstrating the validity of the operational items: unidimensionality, construct reliability, and discriminant validity (Bagozzi 1980). The initial model structure comprised of the thirty-two items was found to have poor model fit; refinements were made to this model by eliminating some items that either had low loadings ($<$0.50) or high cross-loadings (cross-loading $>$0.5). Further, additional refinements were made to the item error correlations using the modification indices as a guide. The final model, comprising twenty-four items for the four dimensions of knowledge embeddedness, is shown in Table 2. As is evident, all the individual item loadings are high and significant. The model fit indices provide ample evidence of the unidimensional validity of the items and their respective dimensions of knowledge embeddedness. Two issues are noteworthy. First, although the root mean square error of approximation (RMSEA) should ideally be less than 0.05, Browne and Cudeck (1993, p. 144) suggest that an RMSEA of less than 0.08 is also a practical evidence of good model fit. Second, the Comparative Fit Index (Bentler 1990) and Tucker-Lewis Index (Tucker and Lewis 1973) are considered to be robust indicators of model fit, and it is recommended that their values be above 0.90. As is evident from Table 2, the values of both of these indicators provide evidence of good model fit.

Table 3a shows assessments of reliability of the operational items for each dimension of knowledge embeddedness. These scores were computed in conformance with the formula prescribed by Werts et al. (1974). Scores above 0.50 indicate that at least 50% of the variance in measurement is captured by the trait variance and are, therefore, evidence of good measurement properties (Bagozzi 1980). As is evident from Table 3a, all the dimensions of knowledge embeddedness pass this criterion.

Discriminant validity refers to the extent to which measures of the different model dimensions are unique and is generally assessed by testing whether the correlations between pairs of dimensions are significantly different from unity (Anderson 1987). This is carried out through pairwise χ^2 difference tests requiring the estimation of twelve

Table 2 Operationalization of Knowledge Embeddedness: Evidence of Unidimensional Validity

Construct and Items	Standardized Parameter Estimate	t-value
Planning knowledge		
Enterprise mission, objectives, and goals	0.70	10.10
Enterprise critical success factors	0.67	9.70
Organization structure/hierarchy	0.70	10.10
Enterprise functions and activities	0.96	16.59
Enterprise data model	0.87	14.09
Analysis knowledge		
Normalized data model	0.73	11.17
Entity types and their relationships	0.80	12.51
Attributes of each entity type	0.81	13.11
Detailed process/activity model	0.94	16.32
Data views for each process	0.95	16.71
Process decomposition diagrams	0.85	14.29
Process dependencies diagrams	0.74	11.43
Process specifications	0.80	12.45
Design knowledge		
Screen/menu layouts and report formats	0.86	14.36
Action diagrams and pseudocode	0.97	17.59
Dialog flow diagrams	0.95	17.07
Data structure diagrams	0.85	14.08
Interfaces to other systems	0.66	9.25
Construction knowledge		
Program structure chart	0.74	11.45
Library of reusable code	0.87	14.40
Executable code	0.84	13.46
Physical database design and tables	0.87	14.27
Security, restart, recovery and audit	0.77	11.77
Stored record formats	0.76	11.74

Notes. Model fit indices:
Goodness of fit (χ^2) with 220 degrees of freedom = 368.79 (p = 0.00)
Root mean square error of approximation (RMSEA) = 0.06
p-value for test of close fit (RMSEA $<$ 0.05) = 0.04
Root mean square residual (RMR) = 0.86
Goodness of fit index (GFI) = 0.87
Adjusted goodness of fit index = 0.82
Tucker-Lewis Index = 0.96
Comparative fit index = 0.97

covariance structures (six constrained and six unconstrained) and evaluation of the χ^2-differences. In order to establish discriminant validity, the χ^2-value of the unconstrained model must be significantly lower than that of the constrained model. Table 3b provides strong evidence of discriminant validity.

Methodology Influence. As described earlier, three variables were identified as capturing the distinct ways in which methodology might influence the assimilation of CASE: prior methodology use, current methodology use, and methodology compatibility. The relevant items and instructions provided to the respondents are shown in Appendix B. First, respondents were asked to name the methodology currently in use at their organization. Then, they were asked to: (1) assess the degree of compatibility between this methodology and their CASE technology, (2) indicate the extent to which this methodology was in use prior to the organizational adoption of the CASE

Table 3a Operationalization of Knowledge Embeddedness: Evidence of Reliability

Construct	Number of indicators	Reliability (Y_c)
Planning	5	0.89
Analysis	8	0.95
Design	5	0.94
Construction	6	0.92

Note. Reliability is calculated in line with the recommendations of Werts et al. (1974).

Table 3b Operationalization of Knowledge Embeddedness: Evidence of Convergent and Discriminant Validity

	Contrained Model		Unconstrained Model		Difference
Test	χ^2	df	χ^2	df	χ^2
Planning with					
Analysis		57		56	
Design		29		28	
Construction		39		38	
Analysis with					
Design		50		49	
Construction		63		62	
Design with					
Construction		32		31	

technology, and (3) indicate the extent to which this methodology was currently in use within the organization.

An examination of the responses regarding prior methodology use revealed that, in approximately 60% of the responding firms, the current methodology was not being used prior to CASE adoption. Apparently, these firms had either instituted the current systems development methodology concurrent with, or subsequent to, the CASE adoption. We found that, subsequent to adoption, the current methodology use within these firms had grown to a high level (mean = 2.80 on a five-point scale). Clearly, this subsample provides empirical evidence for our earlier assertion that some firms might utilize a new methodology as a part of the institutional unfreezing efforts associated with the introduction of CASE. In such instances, the level of current methodology use serves as a surrogate for the mutual adaptation dynamics underlying Hypothesis 3. The remaining 40% of the sample exhibited a high level of use of the current methodology even at the time of CASE adoption (mean = 2.69, on a five-point scale); this provides evidence of an entrenched methodology in those organizations. Taken together, it seems that our sample of organizations exhibits both the institutional rigidity dynamics underlying the hypothesized effects of prior methodology use and the mutual adaptation dynamics underlying the hypothesized effects of current methodology use.

Management Championship. This variable was measured through three items adapted from scales developed in earlier research (Ginzberg 1981, Slevin and Pinto 1987). These items measured the amount of management support for CASE implementation, priority placed on CASE implementation relative to other technologies in the IS organization, and the extent to which the IS management was convinced about the necessity for implementing CASE technology (see Appendix B). Factor analysis showed that the items loaded on a single factor with a high internal consistency (Cronbach's alpha = 0.90).

Control Variables. Organization size was measured as the number of employees in the IS organization (Rogers 1983, Kimberly and Evanisko 1981); a lognormal transform was then applied to the data. Time-since-adoption was measured by asking respondents to indicate the year when the CASE technology was first adopted by their organization. The difference between the year of adoption and the year of this data-gathering venture (1994) was operationalized as the time-since-adoption in years. Project size was measured on an eleven-point scale as shown in Appendix B.

Assimilation of CASE. As illustrated in Appendix B, respondents were asked two questions: First, they were asked to identify the types of projects that used CASE in their organization. The intent of this question was to focus respondents' attention toward the population of projects that used CASE; in some organizations, not all projects are likely to be using this technology (McClure 1989). Next, respondents were asked to indicate the percentage of such projects that had used the CASE technology for at least 25% of the information systems tasks within those projects. We deemed such a threshold to be a relatively conservative and appropriate estimate of diffusion because it eliminated projects that might have used CASE in only a perfunctory manner. Our conversations with CASE experts, as well as our own knowledge and experience, suggest that such a threshold is realistic. Further, respondents were asked to limit their attention to the population of their organizations' systems development projects for just the prior two years. Such a common time horizon enables normalizing the measure across organizations that might have adopted CASE for a different number of years and might have had varying populations of projects in those time periods. By limiting the focus to the last two years, we sought to aid the respondents' recall and ensure a more accurate and valid indication of the proportion of projects using the CASE technology.

Analysis and Results

As mentioned earlier, the full sample ($n = 176$) included respondents from firms using either the IEF or Knowledgeware CASE tool. This full sample was used in assessing the psychometric characteristics of the study's measurement scales. However, in order to exert greater control regarding the features/functionalities of the technology being examined, the remainder of this analysis is confined to the reduced dataset ($n = 124$) of firms using the IEF CASE tool. Tables 4a and 4b display the summary statistics (means, standard deviations, and intercorrelations) of the study's research variables.

Analysis Strategy. Hypotheses testing was conducted using partial least squares (PLS) analysis, a second-generation multivariate regression-based technique for the assessment and estimation of structural models (Fornell and Bookstein 1982, Wold 1982, Lohmoller 1984). The PLS technique is useful for analyzing structural models with multiple-item constructs and mediating constructs. It is an alternative to the more widely known covariance fitting approach for estimating structural equations models (exemplified by software such as LISREL). While LISREL analysis uses the maximum likelihood estimation (MLE) procedure, requires significantly more statistical specifications, and places more rigid constraints on the data, the PLS method avoids many of these difficulties by following a components-based strategy (Fornell and Bookstein 1982, Tabachnik and Fidell 1989). It is a powerful method when the goal of research is predictive accuracy and the explanation of complex relationships, as is the case with the present research (Anderson and Gerbing 1988). The main limitation of the PLS method is that, being a limited information method, the parameter estimates are less than optimal regarding bias and consistency.

One of the advantages of PLS over LISREL is that it allows latent constructs to be modeled either as formative or reflective indicators. Reflective indicators are seen as quantified aspects of a theoretical construct, and are invoked in an attempt to account for the observed variances and covariances. Formative indicators are used for theoretical variables used as categorization and measurement devices for complex phenomena in the real world, and are invoked to minimize residuals in the structural relationship. Thus, formative indicators are used to construct a superordinate construct where the individual indicators are weighted according to their relative importance in forming the construct (Chin 1998, Law et al. 1998). In our model, knowledge embeddedness is implemented as a formative construct, with four indicators: planning, analysis, design, and construction knowledge. The theoretical justification for this modeling approach is that we do not anticipate that all of the four dimensions of knowledge to be stored at comparable levels in the CASE platform. Individual organizations are likely to store different combinations of the knowledge in their repository, even though they might be at similar levels of overall knowledge embeddedness. All the other constructs in the model are operationalized through single indicators.[1]

Because the PLS method makes no prior distributional assumptions about the data, it does not provide significance tests and estimates of confidence intervals for the path coefficients. In order to estimate the significance of the path coefficients, a bootstrapping approach was used, where 250 random samples of observations were generated from the original dataset by sampling through replacement (each sample size was kept similar to the size of the original dataset used for hypothesis testing). The path coefficients were reestimated using each one of these random samples of observations; as a next step, this vector of parameter estimates was used to compute the parameter means and standard errors. These statistics were

Table 4a **Summary Statistics (Means and Standard Deviations) of the Research Variables**

Variables	Mean	Standard Deviation
Planning knowledge[1]	3.37	1.70
Analysis knowledge[1]	6.14	3.01
Design knowledge[1]	3.87	2.80
Construction knowledge[1]	3.64	3.78
Prior methodology use[4]	0.87	1.53
Current methodology use[2]	2.99	1.42
Methodology compatibility[2]	4.40	1.13
Management championship[1]	3.12	0.60
Organization size (log)	1.62	0.73
Project size[1]	3.35	1.98
Time since adoption	3.40	1.89
Assimilation of CASE[3]	5.49	3.07

Notes. These scores are generated for the subsample of IEF respondents used in the hypothesis testing analysis

[1]based on a 10-point scale

[2]based on a five-point Likert scale

[3]based on a 10-point scale

[4]initially measured on a seven-point scale and converted to a five-point scale, as explained in Appendix B

Table 4b Intercorrelations Among Study Variables ($n = 124$) (needs to be redone)

	1	2	3	4	5	6	7	8	9	10	11
1. Planning knowledge	1.0										
2. Analysis knowledge	0.33	1.0									
3. Design knowledge	0.27	0.68	1.0								
4. Construction knowledge	0.25	0.44	0.81	1.0							
5. Prior methodology use	−0.07	−0.09	−0.08	−0.05	1.0						
6. Current methodology use	0.24	0.29	0.32	−0.30	0.28	1.0					
7. Methodology compatibility	0.21	0.28	0.24	0.21	−0.19	0.18	1.0				
8. Management championship	0.28	0.43	0.40	0.37	−0.07	0.54	0.32	1.0			
9. Organization size	−0.08	−0.14	−0.13	−0.10	0.06	−0.13	−0.18	−0.24	1.0		
10. Project size	−0.10	−0.23	−0.36	−0.29	−0.02	−0.28	−0.11	−0.31	0.12	1.0	
11. Time since adoption	0.07	0.22	0.22	0.15	0.16	0.14	0.001	−0.05	0.06	0.14	1.0
12. Assimilation of CASE	0.28	0.45	0.44	0.37	−0.14	0.44	0.22	0.51	−0.24	−0.33	0.16

Note. All correlations of 0.20 or more are significant at $p < 0.05$

then used to compute the significance of the path coefficients. Finally, the approach was replicated with 500 random samples of observations with replacement to assess the stability of the significance of the path coefficients. Overall, this approach is consistent with the recommendations of Bollen and Stine (1992) and has been accepted as a standard practice in estimating the significance of path coefficients in PLS models (for example, Chin et al. 1996, Mooney and Duval 1993).

Analysis Results. Tables 5a and 5b and Figure 2 illustrate the PLS analysis results. As expected, project size possessed a negative influence on CASE assimilation. Unexpectedly, although its path coefficient only approached significance, organization size also exhibited a negative influence; apparently, it is more difficult to introduce a complex knowledge platform into larger, rather than smaller, organizations.

Substantial support was evident for each of the research hypotheses. Knowledge embeddedness was found to have a significant positive influence on the extent of assimilation of CASE ($\beta = 0.26$), thereby providing support for Hypothesis 1. The extent of prior methodology use was found to have a negative influence on the assimilation of CASE ($\beta = -0.30$) (Hypothesis 2), whereas the extent of current methodology use influence ($\beta = 0.33$) (Hypothesis 3) and methodology compatibility ($\beta = 0.25$) (Hypothesis 4) both were found to possess a positive influence. Overall, these predictors and the control variables explained about 45% of the variance in the assimilation of CASE. Further, as posited in Hypotheses 5 and 6, management championship was found to have a significant positive influence on both the level of knowledge embeddedness ($\beta = 0.48$) and the extent of current methodology use ($\beta = 0.51$).

Recall that the research model argues for a causal influence from knowledge embeddedness to the assimilation of CASE, while acknowledging the likelihood of more limited reverse causality. The loadings on the four dimensions of knowledge embeddedness enable an examination of this issue of causal direction. Planning and analysis knowledge, but not design and construction knowledge, were found to be significant. The embedding of planning and analysis knowledge requires the codification and storage of enterprise-level knowledge (mission, objectives and goals, critical success factors, organization structure and hierarchy, business processes, etc.). Such knowledge emerges from an analysis and understanding of the firm, its products and markets, processes, and its competitive strategies. In contrast, much of the design and construction knowledge would be expected to reflect project-level knowledge (design and code segments created for specific projects). Because planning and analysis knowledge are enterprise-oriented, their development is far less dependent on the use of CASE in successive projects. Therefore, our analysis provides some evidence of a causal influence from knowledge embeddedness to the assimilation of CASE. Of course, a thorough investigation of such causal pathways can only occur through a longitudinal research design, a direction for future research.

Discussion and Conclusion

Prevailing institutional forces in organizations can establish considerable inertia and inhibit the appropriate use of technological innovations. Such forces are particularly

Table 5a Results of PLS Analysis: Path Coefficients

Paths	Path Coefficients
Management championship to	
Current methodology use	0.51*
Knowledge embeddedness	0.48*
Knowledge embeddedness to CASE assimilation	0.26*
Current methodology use to CASE assimilation	0.33*
Prior methodology use to CASE assimilation	−0.30*
Methodology compatibility to CASE assimilation	0.25*
Time since adoption to CASE assimilation	0.02
Project size to CASE assimilation	−0.20*
Organization size to CASE assimilation	−0.16

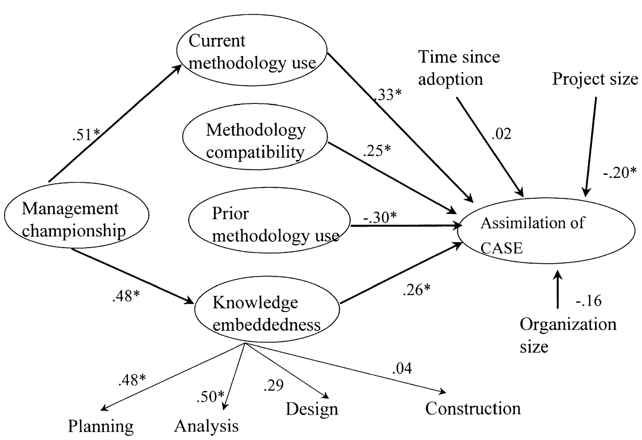
*significant at $p < 0.05$

Table 5b Results of PLS Analysis: Weights of the Dimensions of Knowledge Embeddedness

Dimensions of knowledge embeddedness	Weights
Planning knowledge	0.48*
Analysis knowledge	0.50*
Design knowledge	0.29
Construction knowledge	0.04

*indicates significance at $p < .05$

Figure 2 Results of the Analysis



troublesome with complex technologies, malleable technologies, generic technologies, and with technologies targeted at work domains that are habitually undertaken and that take place within a complex set of administrative and technical policies, rules, and procedures. We feel that knowledge platforms, such as the use of CASE technologies to support an organization's systems development practices, represent just such a context. When attempting to introduce such a technological innovation within such a work domain, we have argued that the prevailing institutional forces could be surmounted by organization-level initiatives. Such initiatives are aimed at unfreezing the established work norms and at providing (administrative and/or technical) incentives motivating both the use of the new technology and the incorporation of the technology within the work unit's current practices.

In our examination of the extent to which systems development organizations have assimilated, or internally diffused, a CASE technology, we argued that two specific metastructuring actions are likely to create a conducive institutional climate: the embedding of useful knowledge within the CASE repository and the concurrent implementation of a compatible systems development methodology. Further, we argued that senior management support, a construct that has received much support in the innovation literature as a key determinant of organizational innovativeness, would reveal itself through its enabling and legitimizing influence on these metastructuring actions, rather than on technology use itself. As reported in the prior section, strong support was obtained for this research model.

Prior to discussing the implications of these findings for both research and practice, it is appropriate to discuss the limitations inherent in our research design. First, the study utilized a cross-sectional survey with a single respondent for each organization. There are at least two potential concerns associated with such a research strategy: common methods variance and the respondent's biases and knowledge base. With respect to common methods variance, most of the issues examined in this research pertain to organizational actions (knowledge embeddedness, CASE assimilation, etc.) rather than individual cognitions or affect. Further, the individuals responding to the questions were CASE or data administrators, and they are expected to have specific organizational responsibility for the actions in question (in smaller organizations, the respondents were systems developers who have significant involvement with their firms' CASE product-implementation actions). Therefore, the organizational role of the respondents and the nature of the issues examined reduce the severity of concerns about the biases and knowledge base of respondents. Another limitation of this study lies with its focus on a single CASE product (IEF) and a single paradigm for knowledge embeddedness (the Information Engineering philosophy). However, we feel that these choices have contributed markedly to the internal validity of the study's research design. Others are encouraged to examine the research model with alternative IT-enabled knowledge platforms and knowledge application methodologies (for example, object-oriented philosophy).

Notwithstanding these limitations, this research makes two significant contributions to the innovation literature regarding the facilitation of postadoption behaviors associated with the introduction of knowledge platforms as well as other complex, malleable, and intrusive technologies. First, the findings clearly demonstrate the value of identifying the nature of organization-level technology-use mediation (metastructuring) actions for overcoming the inertia attributable, in part, to institutional forces that otherwise would be likely to suppress the adaptation and acceptance processes necessary for the technological innovation to become an integral element of an organization's routine work practices. By incorporating such mediation actions, along with other relevant variables as disclosed by the rich literatures on technological, managerial and organizational innovation, we believe that more robust models could be fabricated to explain post-adoptive innovative behaviors in organizations. Second, these findings add to the existing collective knowledge regarding the influence of senior management championship by suggesting that its effect occurs through specific technology-use mediation actions rather than directly on technology use itself. While such an observation is certainly not surprising, we are unaware of prior evidence of such an effect. Accordingly, we encourage other scholars studying postadoptive innovation to take a more granular approach when including the senior management championship construct within their research models.

Our findings also have important implications for managers involved in efforts to introduce complex, malleable, and intrusive technologies—such as knowledge platforms—within their workplace. First, our demonstration of the dampening effects of prior work routines should serve to heighten awareness of how existing work rules, procedures, policies, and norms are likely to inhibit the rich use of these new technology-enabled work platforms. Managers introducing such technologies within their units must respect the pervasive influence of established work routines, must understand how a new technology interacts with these established work routines, and must develop implementation strategies involving the joint adaptation of the unit's work routines and the new technology. Second, the benefits accruing from the careful selection of appropriate technology-use mediation actions cannot be under-emphasized. An ''appropriate'' technology-use mediating action is one that is tailored to the concurrent evolution of the technology and a unit's work routines. In the context of a knowledge platform, ''seeding'' the knowledge base with valued content serves to enhance the relative advantage, and hence the perceived usefulness, of the knowledge platform. Further, the concurrent introduction of work methods and procedures compatible with the content and functionality of the knowledge platform encourage the emergence of work practices that are enriched by and enabled through the knowledge platform. By carefully selecting salient actions to suppress institutional forces or to enhance the site-specific relative advantage of a technology, the likelihood that the new technology will be used should increase. Third, once salient technology-use mediation actions are identified, senior management must actively champion the execution of each, as well as support the overall effort to introduce the new technology into the organization.

Today, organizational transformation is increasingly enabled through the fabrication of complex, malleable, and intrusive technology platforms, with knowledge platforms being but one example. These technology platforms create the potential for work to be organized and executed in novel ways. If these new ways for performing work are matched well with evolving marketplace realities and opportunities, organizational effectiveness can be significantly enhanced. It must be recognized, however, that such transformation initiatives involve a dynamic interplay amongst workers, work processes, work structures, work tasks, and technologies—an interplay embedded within multiple institutional contexts. Without appropriate meta-structuring actions, it is highly unlikely that these transformation initiatives will be successful.

In summary, then, this study has demonstrated the value of incorporating metastructuring actions, i.e., organization-level technology-use mediation actions, into the already robust literature on technological innovation. Additionally, the suggestion that senior management championship of a technological innovation might be most effective when focused on these technology-use mediation actions, rather than the technology itself, promises an enhanced understanding of the underlying dynamics of successful technological innovation. As these ideas are at a formative stage of development, examinations of these ideas by others are strongly encouraged. Still, their inclusion into research models devised to explain the postadoptive behaviors associated with complex, intrusive technologies may very well promote fresh thinking into this exceedingly important phenomenon.

Appendix A. Measurement Items for Knowledge Embeddedness

Using the scale provided, circle the percentage that best indicates the extent to which each item is stored within the CASE repository at your organization. Circle NA for ***not available*** if the CASE product does not store this information.

Planning												
Enterprise mission, objectives and goals	NA	0	10	20	30	40	50	60	70	80	90	100
Enterprise critical success factors and assumptions	NA	0	10	20	30	40	50	60	70	80	90	100
Organizational structure/hierarchy	NA	0	10	20	30	40	50	60	70	80	90	100
Enterprise functions and activities	NA	0	10	20	30	40	50	60	70	80	90	100
Enterprise data model	NA	0	10	20	30	40	50	60	70	80	90	100
Business processes	NA	0	10	20	30	40	50	60	70	80	90	100
Business data flows	NA	0	10	20	30	40	50	60	70	80	90	100
Business policies, rules and events	NA	0	10	20	30	40	50	60	70	80	90	100
Business Requirements Analysis												
Normalized data model	NA	0	10	20	30	40	50	60	70	80	90	100
Entity types and their relationships	NA	0	10	20	30	40	50	60	70	80	90	100
Attributes of each entity type	NA	0	10	20	30	40	50	60	70	80	90	100
Detailed process/activity model	NA	0	10	20	30	40	50	60	70	80	90	100
Data views for each process	NA	0	10	20	30	40	50	60	70	80	90	100
Process decomposition diagrams	NA	0	10	20	30	40	50	60	70	80	90	100
Data flow diagrams	NA	0	10	20	30	40	50	60	70	80	90	100
Process dependencies diagrams	NA	0	10	20	30	40	50	60	70	80	90	100
Process specifications	NA	0	10	20	30	40	50	60	70	80	90	100
Design												
Process flows	NA	0	10	20	30	40	50	60	70	80	90	100
Screen/menu layouts and report formats	NA	0	10	20	30	40	50	60	70	80	90	100
Module structure chart and flow charts	NA	0	10	20	30	40	50	60	70	80	90	100
Action diagrams and/or pseudocode	NA	0	10	20	30	40	50	60	70	80	90	100
Dialogue flow diagrams	NA	0	10	20	30	40	50	60	70	80	90	100
Data structure diagrams	NA	0	10	20	30	40	50	60	70	80	90	100
Interfaces to other systems	NA	0	10	20	30	40	50	60	70	80	90	100
Class definitions	NA	0	10	20	30	40	50	60	70	80	90	100
Construction												
Program structure chart	NA	0	10	20	30	40	50	60	70	80	90	100
Library of reusable code	NA	0	10	20	30	40	50	60	70	80	90	100
Executable code	NA	0	10	20	30	40	50	60	70	80	90	100
Physical database design and tables	NA	0	10	20	30	40	50	60	70	80	90	100
Security, restart, recovery and audit	NA	0	10	20	30	40	50	60	70	80	90	100
Stored record formats	NA	0	10	20	30	40	50	60	70	80	90	100
Test libraries and test cases	NA	0	10	20	30	40	50	60	70	80	90	100

Appendix B. Measurement Items for Key Research Variables

Methodology Influence

1. What is the name and vendor of the software development methodology **currently implemented** within your organization? Fill in 'INTERNAL' for the vendor name if the methodology is developed internally.

   Methodology Name __________ Vendor Name __________

2. What is the primary CASE product **currently implemented** within your organization and when was the product implemented?

   Product __________ Year implemented __________

3. Indicate the extent to which the methodology is compatible with the implemented CASE technology.

   Highly Compatible Compatible Neutral Slightly Compatible Not Compatible

4. Prior to the implementation of CASE, how would you assess the use of the software development methodology currently implemented at your organization. Check **not available** if the methodology was implemented during or after the implementation of CASE:

______	Not available	Score: 0
______	Not used at all	Score: 0
______	A few people/projects experimenting with it	Score: 1
______	A few people/projects regularly use it	Score: 2
______	A number of people/projects use it	Score: 3
______	Most people/projects regularly use it	Score: 4
______	Usage has become a standard	Score: 5

5. *Currently,* how would you assess the use of the software development methodology at your organization:

______	Not used at all	Score: 0
______	A few people/projects experimenting with it	Score: 1
______	A few people/projects regularly use it	Score: 2
______	A number of people/projects use it	Score: 3
______	Most people/projects regularly use it	Score: 4
______	Usage has become a standard	Score: 5

Management Championship

1. IS management support for CASE implementation was:

Very poor   Poor   Adequate   Good   Very good

2. Compared to other information technologies implemented within the IS organization, priority on CASE implementation was:

Very low   Low   Adequate   High   Very high

3. IS management is convinced that the implementation of CASE is necessary.

Strongly agree   Agree   Neutral   Disagree   Strongly disagree

Project Size

Compare, on the average, the size of projects using CASE with projects that do not use CASE. Assume that projects that do not use CASE have a value of 0. Then circle the number that best describes the CASE projects on the scale. For example, if CASE projects are slightly smaller than projects that do not use CASE, circle–1 or –2.

Large Projects   Average Size Projects   Small Projects

+5   +4   +3   +2   +1   0   −1   −2   −3   −4   −5

Assimilation of CASE

Check those categories of projects that identify the types of projects that use CASE in your organization. You can check more than one.

–––– new development projects   –––– upgrade/enhancement projects
–––– reengineering projects   –––– maintenance projects

What percentage of the projects that have been started over the last two years fitting the categories checked above use CASE for at least 25% of the IS tasks within the project?

0%   10%   20%   30%   40%   50%   60%   70%   80%   90%   100%

Endnotes

[1]Note, however, that some of these indicators are being measured through multiple indicators, for example, project characteristics and management championship. In the PLS model, however, the aggregate item scores were used for analysis.

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