ENTERPRISE SYSTEMS, MINIMAL STRUCTURES OF KNOWLEDGE AND ORGANIZATIONAL IMPROVISATION

Suzanne D. Pawlowski[a]
Edward F. Watson[b]
Ivan N. Nenov[c]

[a,b,c]Information Systems and Decision Sciences Department,
Louisiana State University, USA
[a] spawlowski@lsu.edu
[b] ewatson@lsu.edu
[c] inenov1@lsu.edu

Session F-4

Abstract

This paper develops a conceptual framework to examine how enterprise resource planning (ERP) systems may affect knowledge capabilities that enable organizational improvisation. Drawing upon research into knowledge integration, improvisation and communities of practice, a new concept, minimal structures of knowledge, is introduced. In jazz improvisation, minimal structures (e.g., jazz chord progressions) provide the basis for improvisational freedom. Minimal structures of knowledge are defined as boundary objects of cross-practice organizational knowledge that provide a basis for organizational improvisation. The framework is applied to understand the impacts of ERP systems on the integration of knowledge across functional boundaries in new product development. The analysis points to the emergence of new minimal structures of knowledge as one of the potential outcomes of ERP system implementation, which provide enhanced improvisational capabilities for the firm. The discussion suggests that the predominant view of organizational inflexibility as the outcome of ERP systems requires broader examination.

Keywords: ERP systems, knowledge integration, improvisation, minimal structures of knowledge, new product development.

Enterprise systems, minimal structures of knowledge and organizational improvisation

Suzanne D. Pawlowski
Edward F. Watson
Ivan N. Nenov

Information Systems and Decision Sciences Department
Louisiana State University, USA
spawlowski@lsu.edu, ewatson@lsu.edu, inenov1@lsu.edu

Abstract

This paper develops a conceptual framework to examine how enterprise resource planning (ERP) systems may affect knowledge capabilities that enable organizational improvisation. Drawing upon research into knowledge integration, improvisation and communities of practice, a new concept, minimal structures of knowledge, is introduced. In jazz improvisation, minimal structures (e.g., jazz chord progressions) provide the basis for improvisational freedom. Minimal structures of knowledge are defined as boundary objects of cross-practice organizational knowledge that provide a basis for organizational improvisation. The framework is applied to understand the impacts of ERP systems on the integration of knowledge across functional boundaries in new product development. The analysis points to the emergence of new minimal structures of knowledge as one of the potential outcomes of ERP system implementation, which provide enhanced improvisational capabilities for the firm. The discussion suggests that the predominant view of organizational inflexibility as the outcome of ERP systems requires broader examination.

Keywords: ERP systems, knowledge integration, improvisation, minimal structures of knowledge, new product development

Suggested track: Integrating knowledge across organizations

1 Introduction

'Inflexibility,' 'standardization,' and 'conformity' are among the labels commonly used to describe the organizational impacts of enterprise resource planning (ERP) systems. In this paper, we offer an alternative perspective. In contrast to the predominant view, we explore the premise that one of the potential outcomes of ERP system implementation is enhanced knowledge capabilities for knowledge-intensive cross-functional business processes such as new product development. The starting point for our exploration is to shift attention to the impacts of ERP systems on the knowledge capabilities of the firm. While considerable attention has been given to data integration and improved data access as a key driver for the adoption of ERP systems

(Ross, 1999; Markus, Petrie and Axline, 2000; Oliver and Romm, 2002), little attention has been given to the broader impacts of these systems on an organization's knowledge capabilities. The objective of the work presented in this paper is to take this broader view by exploring the following research topics:

- How is knowledge integration realized in firms where ERP systems are used in a cross-functional, process-enabling role?
- In what ways do these knowledge integration capabilities affect organizational improvisation?

In this paper we develop a conceptual framework to explore these questions. The framework draws upon concepts from the three research streams shown in Figure 1 - knowledge integration, organizational improvisation and communities of practice. Building upon this work, we introduce a new concept, *minimal structures of knowledge*. We propose that one of the potential outcomes of enterprise systems is the emergence of new 'minimal structures' of cross-practice knowledge that enhance the firm's improvisational capabilities. Moreover, we suggest that this enhanced capability is positioned at the middle and upper levels of the organization, where business processes can have strategic implications. Minimal structures of cross-functional knowledge, shared by members of management or professional teams representing different business functions, can provide a key knowledge capability that enhances organizational improvisation in areas such as new product development, supply chain management, product lifecycle management, and business process outsourcing.

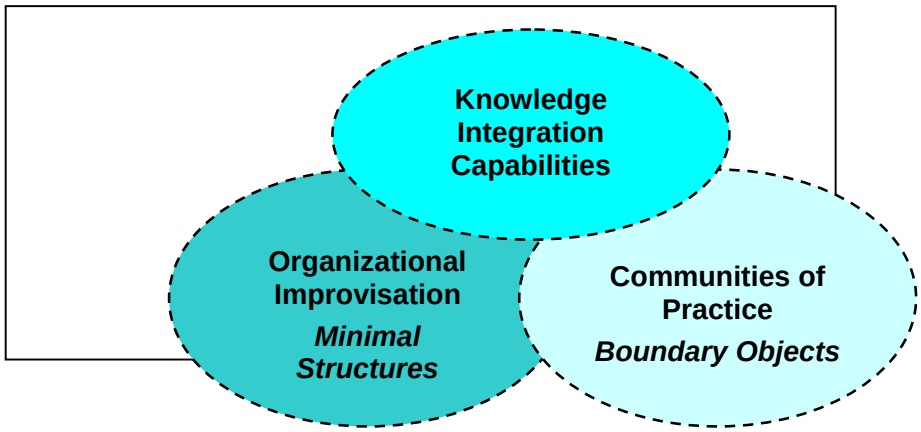


Fig. 1. Sources of Theory Relevant to Knowledge Effects of ERP Systems

The paper begins with an overview of the motivation for the research, particularly in light of today's hyper-competitive business environment. Next, the relevant literature is reviewed and

key concepts are introduced. A detailed description of the conceptual framework follows. We then apply the framework to illustrate how the implementation of an ERP system in a firm may affect the ability to improvise in the context of new product development. Cross-functional product development teams are used by firms to manage knowledge in order to improve time to market and innovation (Eisenhardt and Tabrizi, 1995); Leonard and Sensiper, 1998). Application of the framework to this context provides new insights into the implications of ERP systems on the performance of these teams.

2 Motivation for the Research

Agility and innovation have become watchwords in today's hyper-competitive business environment. Firms are aggressively pursuing a number of different strategies in order to improve their ability to quickly adapt to changing conditions. The facility to rapidly develop new products and services and shift to new methods of organization has become critical for survival. Three priority areas for management focus and action in this environment set the stage for the research in this paper. The first area of emphasis relates to knowledge capabilities. Emerging knowledge-based views of the firm point to knowledge capabilities as a key source of sustainable competitive advantage (Conner and Prahalad 1996; Grant 1996a; Kogut and Zander 1992). Improving the capabilities of the firm to create, transfer, integrate, and manage knowledge is recognized as a critical strategic issue for organizations. The second area receiving management energies is the need to continually innovate in products and services as well as organizational processes/technology (Tornatzky and Fleischer, 1990). As Benner and Tushman (2003) observe, an organization's dynamic capabilities depend on exploratory innovation while simultaneously exploiting current technologies and resources. Improvisation in organizations has also garnered attention because of the linkages between improvisation and innovation. While some improvisations are ephemeral, other improvisational episodes can be retained by the organization and have long-term impact (Miner, Bassoff, and Moorman 2001). A third topic given high priority by top management has been information technology (IT) and how best to leverage and align IT with strategic and operational goals. The adoption of ERP systems was one of the major IT decisions made by large- and medium-sized companies in the 1990s. Davenport (1998:122) characterizes ERP as "the most important development in the corporate use of information technology" of that decade. The implementation of these large, complex integrated software packages has entailed significant organizational change as companies have worked to 'fit the business the software' (Curran and Ladd 1998).

The genesis of our interest in the subject of this paper was the observation that while these three priority areas of management concern – knowledge capabilities, improvisation/innovation and ERP systems – are related, an understanding of those interrelationships is lacking. For example, immediate questions arise related to critiques of ERP systems suggesting that they are inflexible and rigid and, thus, constrain organizational action. On the other hand, agility in manufacturing is one of the primary objectives sought by many organizations in implementing ERP. The picture is also mixed concerning the knowledge impacts of ERP systems. The integration of organizational information and processes, the espoused raison d'etre of enterprise systems, is likely to generate major changes in organizational knowledge in terms of content, distribution and flow. However, organizations have encountered significant knowledge barriers associated with configuration of the ERP packages and with the assimilation of new work processes (Robey, Ross and Boudreau 2002). Clearly, a more holistic understanding of the impacts of ERP systems on improvisation/innovation and organizational knowledge capabilities is needed. The next section gives an overview of theoretical work that guided our investigation of these questions.

3 Theoretical Foundations

3.1 Knowledge integration

Organizational capability is defined as "a firm's ability to establish internal structures and processes that create firm-specific competencies and enable it to adapt to changing external pressures" (Ulrich and Wiersema, 1989:119). Grant (1996a:375) argues that "the primary role of the firm, and essence of organizational capability, is the integration of knowledge." Knowledge capabilities create the greater part of the organizational value-added and the difficulty of replication can create company strategic advantage (Alavi and Tiwana 2002; Kogut and Zander, 1992). Three mechanisms through which knowledge integration is realized are: 1) directives, 2) routines and 3) self-contained task teams (Grant 1996). As we examine each of these mechanisms, some of the potential impacts of ERP systems on knowledge integration capabilities can be discerned. Directives are comprised of specific sets of rules, procedures, heuristics developed through the articulation of specialist's tacit knowledge to non-specialists. Routines are organizational protocols, process specifications and interaction norms used by the individuals to apply and integrate what they know without having to communicate it explicitly (Grant 1996). ERP systems provide embed directives and routines through various system elements, e.g., purported best practices, business blueprints and process maps (Davenport

1998). One of the key themes of this paper is that ERP systems can enhance the knowledge integration of cross-functional task teams.

3.2 Knowledge boundaries and boundary objects

Knowledge boundaries across functional divisions pose challenges to the success of teams and organizations as a whole. Communities of practice theory (Brown and Duguid 1991, Lave and Wenger 1991, Wenger 1998) provides a useful lens to understand these challenges. A community of practice is an informal aggregation of individuals engaged in common enterprise and distinguished by the manner in which its members interact and share interpretations. Each community of practice develops a local world view that reflects its shared knowledge, values, meanings, assumptions, beliefs, and practices (Wenger 1998). Knowing and knowledge (local and cross-practice) are situated in practice, and knowledge is continually emerging through the negotiation of meaning within the context of practice (Wenger 1998). Viewing an organization as a collective of communities of practice, organizational knowledge boundaries arise because specialized knowledge is localized, embedded invested in practice (Carlile 2002). Knowledge integration across these boundaries can be problematic. Bechky's (2003) study of occupational communities (engineers, technicians and assemblers) on a production floor, for example, found that knowledge-sharing difficulties were caused by differences in language, the locus of practice and conceptualization of the product.

A boundary object is one mechanism that enables the coordination of efforts among communities of practice. Boundary objects function as interfaces between communities of practice, enabling communities to organize their interconnections (Wenger 1998). A crucial quality of boundary objects that facilitates sharing and coordination is flexibility, allowing for multiple interpretations and uses by the multiple practices employing them (Star and Griesemer 1989). ERP systems and related artifacts, for example, can be viewed as boundary objects that interconnect communities of practice across the organization in new ways. The new concept introduced in this paper, minimal structures of knowledge, can also be viewed as a boundary object.

3.3 Improvisation and Minimal Structures

Miner et al. (2001) define improvisation as occurring when the design and execution of novel action converge. Improvisation, for example, can come into play when a person or group searches for a precedent or referent that will help them deal with a situation where no script is

immediately available (Mangham and Pye 1991). Improvisation has become a critical capability for firms to deal with environmental conditions of uncertainty, complexity and dynamism (Moorman and Miner 1998). Montuori (2003:245) describes improvisation as "a dance of constraints and possibilities."

Theorists draw upon the metaphor of jazz to develop insights into organizational improvisation (Bastian and Holstager 1988). A central idea in this work relates to role of structure in improvisation, specifically the notion of minimal structure (Barrett and Peplowki (1998) and Kamoche and Cunha (2001)). Jazz improvisation "is guided by a non-negotiable framework that constrains what soloists can play. This structure provides the necessary backdrop to coordinate action and organize choice of notes." (Barrett and Peplowski 1998:558). Musicians use the structure in creative ways that enable them to alter the structural foundations of their playing (Hatch 1999). It is this 'minimal structure,' then, that provides the basis for improvisational freedom. Extending these ideas to the organizational context, improvised performance is both constrained and facilitated by structures of different types and levels, e.g., institutional and macro-level structures (Powell and DiMaggio 1991), organizational structure (Brown and Eisenhardt 1997).

Kamoche and Cunha (2001) see minimal structures as being comprised of two elements: social structures and technical structures. To illustrate, they develop a 'minimally structured' improvisational model for new product development, relating social and technical structures in that process with similar structures in jazz improvisation. For example, the social structures of communicative codes, call-response, hand signals and eye contact in jazz improvisation are related to the social structures of cross-functional and cross-project communication and networking in new product development. Experimenting with new instruments, styles and textures of sound as examples of technical structures in jazz improvisation are related to application of unusual tools, methods and technologies, creating experimental products, bricolage and multiple iterations and testing in new product development. In the next section, we apply these ideas to develop a knowledge view of minimal structures in order to explore our research questions on the relationships among ERP systems, knowledge integration capabilities and organizational improvisation.

In addition to the concept of minimal structure, we draw upon Moorman and Miner's (1998) insights into the influence of prior routines and knowledge of the improvising units and the role of procedural and declarative knowledge in improvisation. Development of their ideas began with Brown and Eisenhart's work (1995) suggesting that organizations with deep technological

routines have higher likelihood of generating improvisation in new product development and that learned routines shape improvisation in new product development. The processing of organizational memory (stored knowledge) is a key factor in the effectiveness of organizational improvisation. Moorman and Miner (1998) argue that procedural and declarative memory moderate the relationship between improvisation and organizational outcomes and that over time improvisation can have an effect on the development of organizational memory. Where procedural memory is defined as the memory of "how things are done" (Cohen and Bacdayan, 1994:404) or memory for "things you can do" (Berliner, 1994:102). Thus, procedural memory entails skills or routines. An important characteristic of procedural memory is that it becomes embedded or accessible unconsciously. Declarative memory is "memory for facts, events, or propositions" (Anderson, 1983; Cohen, 1991: 137). Declarative memory is more general than procedural memory. The main characteristic of declarative memory is that it can be employed for a variety of uses. Declarative knowledge allows the use of the same knowledge for different needs. Procedural and declarative memories have different effects on improvisation. Procedural memory enhances the prospect that improvisation will result in coherent and rapid action, but it increases the risk of automatic behavior, whereas declarative memory permits richer, more complex meanings and connections. However it demands substantial search time thus making timely improvisation less likely (Moorman and Miner, 1998).

The inference is that how often improvisation produces novel action could be reliant on whether the improviser is able to use declarative memory to make creative use of procedural memory (Moorman and Miner, 1998). Necessary skills might include: utilizing pre-existing routines to new contexts; recombining subunits within pre-existing routines; and recombining entire routines in new ways. On the other hand, the potential complementary impact of declarative and procedural knowledge on organizational improvisation is contingent upon the ability to use declarative memory to make creative use of procedural memory, and the development of procedural skills that allow for rapid access to declarative memory stores (Moorman and Miner, 1998).

4 Minimal Structures of Knowledge

At this point we return to the research questions that motivate the work in this paper. Our goal is to understand the relationships between ERP systems, knowledge integration capabilities and organizational improvisation. Kamoche and Cunha's (2001) improvisational model for new product development include various types of minimal structures related to that context (e.g.,

social interaction norms, template of the product concept, functional skills, experimentation). However, because this inquiry relates to knowledge capabilities and improvisation, we focus our analysis by introducing a new concept - 'minimal structures of knowledge.' Minimal structures of knowledge are defined as:

1) boundary objects,
2) comprised of cross-practice organizational knowledge
3) that enable communities of practice in an organization to coordinate their actions, and
4) serve to facilitate and constrain organizational improvisation.

Minimal structures of knowledge are, then, a particular type of boundary object and particular type of minimal structure related specifically to cross-practice boundary knowledge. Paraphrasing Barrett and Peplowski (1998), minimal structures of knowledge provide the necessary backdrop of knowledge to coordinate and organize the choice of organizational actions where there are cross-practice linkages and dependencies.

As boundary objects, minimal structures of knowledge enable communities of practice to organize their connections. A key characteristic of boundary objects is flexibility - "both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites" (Star and Griesemer 1989: 393). However, minimal structures of knowledge as boundary objects have more limited interpretive flexibility. Here, the requirement for interpretation and meaning within a practice also incorporates the knowledge of the linkages and interdependencies among the practices related to that object. It is this cross-practice knowledge that enables one community of practice to understand how the actions of that community may impact other practices. Minimal structures of knowledge facilitate improvisation through an understanding of the cross-practice implications of considered actions.

The quote below, from a case study of knowledge brokering by IT professionals at a large manufacturing and distribution firm (Pawlowski 2001) illustrates the importance of cross-practice knowledge and the role that minimal structures of knowledge can play in evaluated proposed actions that may impact multiple practices. An information systems development manager describes the knowledge broker role he was able to play based on his knowledge of the linkages between the practices of two functional areas he supported – Accounting and Sales:

> Just the other day Accounting came up with something that they wanted to do, and they were just adamant that they wanted to do it. And I went to the Sales guys and said "Do you understand what this means and how this is going to affect you?" Because Accounting had already run it by Sales…supposedly. And so when I sat down and really laid it out to them as to what that really meant, they said "No, there's no way we're going to do that."
>
> *(Senior Manager, Information Systems Development)*

In this example, the IT manager had a level of cross-practice knowledge (a minimal structure of knowledge) that enabled him to understand the implications of the proposed actions of the Accounting group on the Sales group in that organization. Cross-practice knowledge of this type can be used to stimulate ideas concerning new organizational actions as well as to assess proposed actions.

In the next section, we elaborate these ideas by showing how the implementation of an ERP system in an organization may create the emergence of new minimal structures of cross-practice knowledge.

5 ERP Systems and Minimal Structures of Knowledge

5.1 ERP systems – An overview

Enterprise resource planning (ERP) is a set of activities designed to solve the fragmentation of information and processes in large business organizations (Davenport, 1998). An ERP system is an integrative mechanism, which has at its core a shared database that connects the diverse departments through compatible software modules. (See Table 1.) The installation of the ERP requires considerable investment in money, time, and expertise. ERP utilizes very complex pieces of software. Oftentimes, businesses need to modify their strategy, organization and culture to adapt to an ERP system. Because modifications to the new system are unfeasible, companies are driven toward redesigning its organization around core processes (Hammer and Champy 2001, Davenport 1992). Frequently this involves shifting focus, incentive, and responsibility from a traditional functional structure to a process based structure.

Examples of business processes supported by ERP include order fulfillment, procurement, manufacturing planning and execution, human resource management, and financial management. The transition to ERP involves stakeholders at different levels of the organization (e.g., process owners, functional managers and end users). With

Table 1. Key Attributes of ERP Systems (from Davenport (1998))

- Common database
- Broad application modules
- Process integration
- Standardization and discipline
- Configurable, packaged solution => practices can be shared across organization and across industry.
- Real-time access to data and information
- Best business practices (best way to do something), business blueprints (a comprehensive design of a systems of processes), and process maps (high level meta-maps of business processes)
- Implementation tools – provides how to implement and upgrade methodologies including project management, change management

respect to knowledge integration, the broadest level of integration occurs at the process owner level. In addition, end users typically require greater breadth of business knowledge, and with employee training emphasizing whole processes rather than narrow tasks.

Following the implementation of an ERP system, much of the core business processes are more standardized and routinized. The key structural issue in ERP is process standardization versus process diversification. Companies without an ERP system are generally structured around strategies that involve centralization versus decentralization and allowing customization at the local level. Hammer and Stanton (1999) identify three main benefits of process standardization: 1) lower overhead costs, 2) reducing transaction costs, and 3) increasing organizational flexibility. They argue that organizational flexibility is enhanced by standardization because processes are performed in the same way throughout the company, and this allows shifting of people to where they are needed.
They also warn that over-standardization might create inability to meet the customer's diverse needs. Because companies do not generally compete on standard business processes, by implementing ERP, moving to an integrated architecture, and adopting best practices enables them to squeeze out waste, adopt streamlined practices, thus providing the organization with more freedom and flexibility to pursue more strategic initiatives.

Introduction of enterprise system provides seamless integration of company wide flow of information. The enterprise system database collects data from and feeds data into modular applications supporting virtually all of a company's business activities across functions, units and geography. This gives universal, real-time access to operating and financial data allowing companies to streamline their management structures with flatter, more democratic organizations (Davenport, 1998). For many companies, these benefits have translated into dramatic gains in productivity and speed.

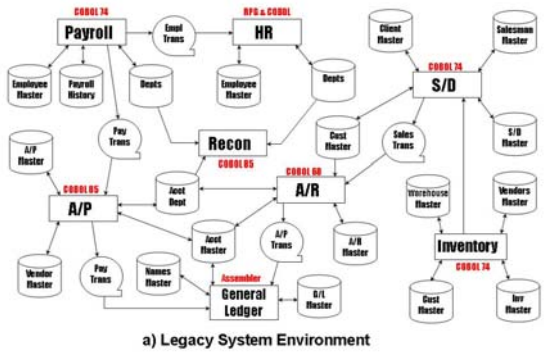
ERP systems enhance problem-solving capabilities. When problems occur (e.g., a customer's order is misplaced or has excessive quality issues, or experiences a recall, a key vendor's plant is hit by a tornado, customer requirements change radically), process owners/end users are able to utilize their expanded cross-functional knowledge. This knowledge, leveraged by users to access important process details and data provided by the integrated ERP system, can be utilized to develop problem solutions, including improvisation of new solution strategies. This

level of problem-solving capability stands in contrast to legacy systems where problem-solving was limited by a much more local view of organizational knowledge and access to data.

5.2 A historical view - Enterprise systems as an evolving artifact

While the discussion in the previous section focused specifically on ERP systems, in this section we place ERP systems in the historical context of enterprise systems, identifying patterns of evolution that may provide indications for future evolution of these systems. First, enterprise systems are an evolving IT artifact. Three periods of that evolution are portrayed in Figure 2. The enterprise systems environment of the pre-90's (period 1) is referred to as the legacy systems environment. Integration was achieved through hard-wired interfaces. Therefore processes were typically fragmented and not standardized. This is more accurately referred to as the pre-enterprise systems period. In the 1990s, enterprise systems entered the scene as the ERP systems environment (period 2). In a simplified analogy, ERP did to enterprise productivity what the Microsoft Office Suite did to office productivity. The third period referred to in Figure 2 represents the e-Business systems suite environment. Based on the core principal of integration and process-orientation, this represents two key points: 1) the enterprise system suite refers to a strategic collection of systems that transcend pure transactional applications by possessing advanced functionality such as decision support, data mining, and optimization; 2) a common data platform that facilitates standardization and enables integration of (organizational) boundary spanning processes. Hence, data transparency across organizations is more attainable.

Several points can be taken from Figure 2. First, the enterprise system artifact continuously evolves. This is exemplified by the empty honeycomb structure in the ERP system environment (period 2). "Enterprise systems," then, is an evolving concept, while ERP refers to a specific kind of enterprise system. For instance, as the ERP evolves, the IT artifact incorporate new functionality, new analytics and new processes,. These new features generally originate from two sources: 1) Derived through application

<table>
<tr>
<td> 

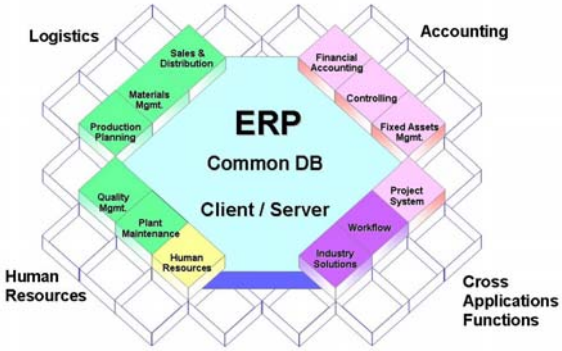
a) Legacy System Environment</td>
<td>Legacy System Environment

Disparate data and information sources

Business processes are fragmented

Business process knowledge is fragmented and scattered. Knowledge of business practices and processes are scattered and not easily transferred from one part of the business to another.

Information systems reinforce process fragmentation.

Emphasis is on applications interfacing.</td>
</tr>
<tr>
<td> 

b) ERP Framework</td>
<td>ERP System Environment

Common, centralized data and information sources

Business processes are seamlessly integrated.

Core business process knowledge (e.g., best business practice, processes and procedures) are standardized and codified, and easily transferred across organization and across industry.

Emphasis is on business process integration.</td>
</tr>
<tr>
<td> 

c) Enterprise Systems Suite (e-Business Framework)</td>
<td>e-Business System Environment

Common, centralized data and information sources within the organization. Can be transparent across organizations.

Business processes are seamlessly integrated and may extend outside the organization.

Advanced business process knowledge (e.g., analytics, simulation, decision support) are standardized and codified, and easily transferred across organization and across industry.

Trend towards mobile and collaborative models.

Emphasis is on business process innovation.</td>
</tr>
<tr>
<td colspan="2">Sources:

a) Hypothetical scenario
b) Adapted from an SAP Presentation at LSU (1999)
c) Adapted from Kalakota and Robinson (2001)</td>
</tr>
</table>

Fig. 2. Enterprise Systems Evolution

experience (i.e., what is learned from continuous use of the enterprise system, especially through feedback from the customer to the software vendor), and 2) Derived from new features developed outside of the enterprise systems environment, based on theory and principles. This can be seen as 'IT commoditization in action.' As technology is applied to new situations, we are forced to understand and map processes, and then automate parts of those processes. The technology becomes a reusable commodity which can then be utilized and shared across organizations, across industries, and so on. This enables learning by analogy, which is a very powerful technique in product design.

The ERP artifact evolved through years of trial-and-error experience – lessons learned by dealing with the difficulties encountered in the transition from the legacy system environment. Endless design, development and implementation of processes, flows and templates in cross-functional implementation teams results in the emergence of new minimal structures of knowledge that serve as the foundation and referent for organizational improvisation. Similarly, the ERP artifact can be seen as a knowledge repository, containing codified declarative memory and procedural memory previously available from experts, both internal and external to the company. In practice this evolution of ERP packages has allowed software vendors to begin developing and formalizing many higher level knowledge processes such as Product Lifecycle Management.

Improvisation typically has a referent or an 'underlying formal scheme or guiding image.' The business practices and routines that have been articulated in the ERP systems, processes and methodologies are, in fact, templates or referents (i.e., basic, core cross-functional data and information required in a timely manner) which managers can use as the foundation to facilitate improvisation. This type of improvisation is realized at the "transaction level" with such processes as dealing with customer service issues revolving around a customer order; dealing with vendor issues at the purchase order level; and Dealing with manufacturing planning and execution issues at the manufacturing order level.

In Table 2, we summarize some of the key changes as organizations moved from legacy enterprise systems to ERP systems, illustrated through the context of Customer Order Management. This profile can be used to understand the potential impacts of this

transition on organizational memory, organizational improvisation and minimal structures of knowledge. Looking to the future, these same patterns can be seen in the evolution from legacy systems to ERP systems and its third phase, the "e-Business" environment. In this new phase of enterprise software, vendors have already begun to articulate certain higher-level knowledge-

Table 2. Transition from Legacy Environment to ERP Environment

Legacy	Transition	ERP
Improvisation **Scenario: Customer Order Management (COM)**		
Internally focused Must compensate for lack of discipline, disintegration, paper-based, batch processing. Focus is on cost cutting and productivity not customer satisfaction.	<= **Improvisation Process** =>	**External focused** Worker is empowered by ERP, focus is on efficiency and customer satisfaction.
Neutral Focus on avoiding problems	<= **Derived Value** =>	**High** Focus is on adding value
Memory		
Manual and Disparate. Core knowledge to support COM process is primarily **tacit** and individualized. It is difficult to transfer to other people, organizations or industries.	<= **Declarative Memory** => General facts, events, propositions. A basis for transfer between different uses of the same knowledge. <= **Procedural Memory** => Skills, routines, and how things are done. Becomes automatic or accessible unconsciously.	**Codified & Centralized**. Core knowledge to support COM process is articulated and digitized and applied across organizations and industries. **Declarative knowledge** includes best business practices. **Procedural knowledge** includes implementation methodologies for project mgmt., change mgmt., and systems configuration.
Minimal Structure		
Functional orientation.	**Mental Model**	**Process orientation** (cross-functional)
Business rules are individualized. Constraints include disparate data sources, lack of standards, …	**Business rules/constraints**	Business rules grounded in best practices; constraints are related to business functions and not business support functions.
Manual, paper-based. Loosely coupled.	**Linkages among business processes**	Tightly coupled, automated linkages (through workflow), common database and standardization of practices, routines, and terminology.
Paper-based Multiple inconsistent views of data and organization	<= **Boundary Objects** => Interfaces between communities of practice	ERP Multiple diverse but consistent views of data and organization.
0-20%	<= **Standardization** => What is done that is shared across organization, within industry, or across the supply chain and industries?	**50-80%**
Batch processing, paper-based environment leads to major efforts required to compensate for inefficiency.	<= **Time** => The more improvisational an act, the narrower the time gap between composing and performing, designing and producing, or conceptualizing and implementing.	**Real-time** access to critical information on-demand.

intensive business processes in their software (e.g., SAP's Product Lifecycle Management solution).

5.3 ERP and knowledge and improvisational capabilities in new product development

In this section, we outline organizational knowledge and improvisation capabilities that we posit are impacted by the implementation of an ERP system:

- *Organizational memory*

In the transition from legacy to ERP environments, declarative and procedural memory elements are learned, routinized, and codified. The integrated business practices and ERP-related methodologies guide business change and on-going business activity. Organizational capabilities are enhanced as this memory can better be leveraged for more knowledge-intense activities such as new product development.

- *Minimal structures (boundary objects)*

In the transition from legacy to ERP environments, minimal structures evolve from functional-oriented mental models to process-oriented (cross-functional) mental models. This shift has implications for organizational structures, organizational routines, and social and behavioral routines and practices. The cross-functional perspective is more conducive to supporting knowledge intense and collaborative activities. These activities are greatly facilitated by the enhanced memory and structures that ERP implementation provides. The minimal structure offers an appropriate level of responsibilities, priorities and procedures that are clearly defined and combined with wide *zones of maneuver.* The interfaces between communities-of-practice become more consistent, user-friendly, automatic and visible, thus more easily facilitating the improvisation process.

- *Standardization*

Increased standardization and discipline enables better communication, efficiency and effectiveness.

- *Improvisation*

Enhanced minimal structures maximize improvisation outcomes. Improvisation is an intense activity that requires significant focus. Thus pulling valuable resources away from non-value added activities (such as routine business processes) and towards value-added activities such as new product development, supply chain management and business intelligence may represent one of the greatest benefits of ERP.

Moorman and Miner (1998) suggest that “improvisation typically has a referent or ‘an underlying formal scheme or guiding image’ (Pressing, 1984; 346). Yet, the (customer) order is not fully predesigned and, in that sense, is partial. If the order were derived solely from following standard procedures, it would not be considered to be improvisation.” Memory (both declarative and procedural) serve as this necessary referent. The minimal structure also represents a mindset. ERP, for instance, provides a process-oriented mindset. Thinking in terms of “what is the process” instead of “what is my task” forces cross-functional action.

In what ways might these changes affect new product development? To examine this question, we reflect upon the experiences shared with us in our recent study of companies in the fashion industry in Northern Italy. The new product development process in that environment typically involves professionals/experts from a number of different areas such as fashion design, marketing, engineering, manufacturing, and finance, as well as business executives. Each of these individuals would bring with them a set of competencies that could span different domains of expertise and business experience, e.g.,:

- Trends or Competitive Intelligence (e.g., fashion trends, customer behaviors/trends, engineering advances, manufacturing advances, financial/risk)
- History and Experiences; lessons learned in projects or product development efforts (e.g., how the consumer reacted to a certain product in a certain environment)
- Theory and Science (e.g., materials science, science of color, marketing theory)
- Processes and procedures (e.g., methodologies for implementing plans, project management)
- Artistic competencies and creativity

(See Table 3) In the transition from the legacy system environment to the ERP system environment, the amount of “improvisation” required to execute the customer order management process (for instance) was drastically reduced. In addition, the amount of knowledge integration that involved face-to-face collaboration was drastically reduced. Processes became more standardized and more automated.

But the net effect has been that, at a higher level such as new product development, the minimal structure of knowledge has radically changed to a mindset that is cross-functional. Also, the memory has been enhanced with a new referent that the enterprise system has captured

and codified. This referent of core knowledge is necessary to support all higher level knowledge processes.

Table 3. Data/Information/Knowledge Impacts – Enterprise Systems Transitions

	Legacy Systems	ERP	e-Business
Product Design	▒	☺	☺
Manufacturing	▓	☺	☺
Financial	▓	☺	☺
Marketing	▓	▓	☺
Executive	▓	▓	☺
Partners	▓	▓	▒
Fashion Design	▓	▓	▒
▓ = data, information and knowledge is not easily accessed ▒ = data, information and knowledge is accessed typically via an interface ☺ = data, information and knowledge is most seamlessly integrated			

6 Conclusion

In this paper, we have sought to expand current understandings of the organizational impacts of ERP systems. We have proposed that one of the potential outcomes of ERP implementation is the emergence of minimal structures of cross-practice knowledge that enable organizational improvisation. This view stands in contrast to critiques of ERP systems as limiting the choice of organizational action, and suggests that a broader understanding of the potential impacts of these systems is needed. Minimal structures of cross-practice knowledge, based on new understandings of the linkages and dependencies across practice boundaries, have the potential to provide a foundation for effective action. Self-contained task teams are one of the primary mechanisms used by organizations to integrate specialized knowledge in critical processes such as new product development (Grant 1996). Cross-functional new product development teams, however, can encounter challenges in recognizing and reconciling their different perspectives in order to innovate and achieve successful outcomes (Dougherty 1992; Ancona and Caldwell 1992). As Weick (1998:552) observes, the ability “to identify or agree on

minimal structures for embellishing" is one characteristic of groups that can lead to a high capability of improvising. Perhaps the development of minimal structures of knowledge as discussed in this paper may be one mechanism to help create that capability.

Acknowledgements

The work in this paper is partly supported by grant LEQSF(2002-05)-RD-A-07 from the Louisiana Board of Regents. We would also like to thank Evgeny Kaganer for the contribution of his ideas to the paper.

References

Alavi, M., & Tiwana, A. (2002): Knowledge Integration in Virtual Teams: The Potential Role of KMS., Journal of the American Society for Information Science & Technology, 53, 12, 1029-1037.

Ancona, D.G., and Caldwell, D.F. (1992): Bridging the Boundary: External Activity and Performance in Organizational Teams, Administrative Science Quarterly, 37, 634–665.

Anderson, J. R. (1983): The architecture of cognition. Cambridge, MA: Harvard University Press.

Baker, T., Miner, A.S., and Eesley, D.T. (2003): Improvising Firms: Bricolage, Account Giving and Improvisational Competencies in the Founding Process, Research Policy, 32, 255-276.

Barrett, F.J., and Peplowski, K. (1998): Minimal Structures With a Song: An Analysis of 'All of Me', Organization Science, 9, 5, 558-560.

Bastien, D.D., and Hostager, T.J. (1988): Jazz as a Process of Organizational Innovation, Communication Research, 15: 582-602.

Bechky, B.A. (2003): Sharing Meaning Across Occupational Communities: The Transformation of Understanding on a Production Floor, Organization Science, 14, 3, 312-330.

Benner, M.J., and Tushman, M.L. (2003): Exploitation, Exploration, and Process Management: The Productivity Dilemma Revisited, Academy of Management Review, 28, 2, 238-256.

Berliner, P. F. 1994. Thinking in jazz: The infinite art of improvisation. Chicago: University of Chicago Press.

Brown, J.S., and Duguid, P. (1991): Organizational Learning and Communities-of-practice: Toward a Unified View of Working, Learning, and Innovation, Organization Science, 2, 1, 102-111.

Brown, S. L., & Eisenhardt, K. M. (1995): Product development: Past research, present findings, and future directions. Academy of Management Review, 20: 343-378.

Brown, S.L., and Eisenhardt, K.M. (1997): The Art of Continuous Change: Linking Complexity Theory and Time Paced Evolution in Relentlessly Shifting Organizations, Administrative Science Quarterly, 42: 1-34.

Kamoche, K. and Cunha, M. (2001): "Minimal Structures: From Jazz Improvisation to Product Innovation", Organization Studies, 22,5, 733-764.

Carlile, P.R. (2002): A Pragmatic View of Knowledge and Boundaries: Boundary Objects in New Product Development, Organization Science, 13, 4, 442-455.

Cohen, M. D. 1991. Individual learning and organizational routine: Emerging connections. Organization Science, 2: 135-139.

Cohen, M. D., & Bacdayan, P. (1994): Organizational routines are stored as procedural memory: Evidence from a laboratory study. Organization Science, 4: 554-568.

Conner, K., and Prahalad, C.K. (1996): A Resource-based Theory of the Firm: Knowledge Versus Opportunism, Organization Science, 7, 5, 477-492.

Contu, A., and Willmott, H. (2003): Re-Embedding Situatedness: The Importance of Power Relations in Learning Theory, Organization Science, 14, 3, 283-296.

Curran, T.A., and Ladd, A. (1998): SAP R/3 Business Blueprint, Prentice-Hall, Upper Saddle River, NJ.

Davenport, T.H. (1992): Process Innovation: Reengineering Work Through Information Technology, Harvard Business School Press.

Davenport, T.H. (1998): Putting the Enterprise into the Enterprise System, Harvard Business Review, 12, 5, 121-131.

Dougherty, D. (1992): Interpretive Barriers to Successful Product Innovation in Large Firms, Organization Science, 3, 179-202.

Eisenhardt, K.M., and Tabrizi, B.N. (1995): Accelerating Adaptive Processes - Product Innovation in the Global Computer Industry, Administrative Science Quarterly, 40, 1, 84-110.

Grant, R.M. (1996a): Prospering in Dynamically-competitive Environments: Organizational Capability as Knowledge Integration, Organization Science, 7, 4, 375-387.

Grant, R.M. (1996b): Towards a Knowledge-based Theory of the Firm, Strategic Management Journal, 17, 109-122.

Hammer, M., and Champy, J. (2001): Reengineering the Corporation Revised Edition: A Manifesto for Business Revolution, HarperCollins.

Hammer, M., and Stanton, M. (1999): How Process Enterprises Really Work, 6, 108-119.
Hatch, M. J. (1997): Jazzing up the theory of organizational improvisation. In J. P. Walsh & A. S. Huff (Eds.), Advances in strategic management, vol. 14: 181-191.

Hatch, M. J. (1999): Exploring the empty spaces of organizing: How improvisational jazz helps redescribe organizational structure, Organization Studies, 20, 1, 75-100.

Huang, J.C., Newell, S., and Pan, S-L. (2001): The Process of Global Knowledge Integration: A Case Study of a Multinational Investment Bank's Y2K Program, European Journal of Information Systems, 10, 161-174.

Kamoche, K., Cunha, M.P. (2001): Minimal Structures: From Jazz Improvisation to Product Innovation, Organization Studies, 22, 5, 733-764.

Kalakota, R., and Robinson, M. (2001) e-Busines 2.0: Roadmap for Success (2nd edition), Addison-Wesley.

Kogut, B., and Zander, U. (1992): Knowledge of the Firm, Combinative Capabilities, and the Replication of Technology, Organization Science, 3, 3, 383-397.

Lave, J., and Wenger, E. (1991): Situated Learning: Legitimate Peripheral Participation, Cambridge University Press, New York, NY.

Leonard, D., and Sensiper (1998): The Role of Tacit Knowledge in Group Innovation, California Management Review, 40, 3, 112-132.

Mangham, I. L., and Pye, A. (1991): The Doing of Managing, Oxford, Basil Blackwell.

Markus, M.L., Petrie, D., and Axline, S. (2000): Bucking the Trends: What the Future May Hold for ERP Packages, Information Systems Frontiers, 2, 2, 181-193.

Miner, A.S., Bassoff, P., and Moorman, C. (2001): Organizational Improvisation and Learning: A Field Study, Administrative Science Quarterly, 46, 304-337.

Montuori, A. (2003): The Complexity of Improvisation and the Improvisation of Complexity: Social Science, Art and Creativity, Human Relations, 56, 2, 237-255.

Moorman, C., and Miner, A. (1998): Organizational Improvisation and Organizational Memory, Academy of Management Review, 23, 4, 698-723.

Oliver, D., and Romm, C. (2002): Justifying Enterprise Resource Planning Adoption, Journal of Information Technology, 17, 199-213.

Orlikowski, W.J. (2000): Using Technology and Constituting Structure: A Practice Lens for Studying Technology in Organizations, Organization Science, 11, 4, 404-428.

Orlikowski, W.J. (2002): Knowing in Practice: Enacting a Collective Capability in Distributed Organizing, Organization Science, 13, 3 249-273.

Pan, S-L., Newell, S., Huang, J.C., and Cheung, A.W.K. (2001): Knowledge Integration as a Key Problem in an ERP Implementation, Proceedings of the Twenty-Second International Conference on Information Systems, 321-328.

Pawlowski, S.D. (2001): Managing the Ties that Bind: An Investigation of the Broker Role of IT Professionals, Ph.D. dissertation, Computer Information Systems Department, Georgia State University.

Powell, W.W., and DiMaggio, P.J., eds. (1991): The New Institutionalism in Organizational Analysis, Chicago, University of Chicago Press, 63-82.

Pressing, J. (1984): Cognitive processes in improvisation. In W. R. Crozier & A. J. Chapman (Eds.), Cognitive processes in the perception of art: 345-363. Amsterdam: North-Holland.

Robey, D., Ross, J.W., and Boudreau, M-C. (2002): Learning to Implement Enterprise Systems: An Exploratory Study of the Dialectics of Change, Journal of Management Information Systems, 19, 1, 17-46.

Ross, J.W. (1999): The ERP Revolution: Surviving Versus Thriving, Sloan School of Management, Center for Information Systems Research, Massachusetts Institute of Technology.

Star, S.L., and Griesemer, J.R. (1989): Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-1930, Social Studies of Science, 19, 387-420.

Tornatzky, L.G., and Fleischer, M. (1990): The Processes of Technological Innovation, New York: Lexington.

Ulrich, D., and Wiersema, M.F. (1989): Gaining Strategic and Organizational Capability in a Turbulent Business Environment, The Academy of Management Executive, 3, 2, 115-122.

Weick, K.E. (1998): Improvisation as a Mindset for Organizational Analysis, Organization Science, 9, 5, 543-555.

Wenger, E. (1998): Communities of Practice: Learning, Meaning and Identity, Cambridge, UK: Cambridge University Press.

Zander, U., and Kogut, B. (1995): Knowledge and the Speed of the Transfer and Imitation of Organizational Capabilities: An Empirical Test, Organization Science, 6, 1, 76-92.