

Dimensions of Organizational Design: The Architectural Continuum and Knowledge Binding

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This issue draws from our May 2000 Conference on Knowledge Management. The first article explores knowledge binding, the process by which knowledge is created and applied. The second describes how one leading company is dealing with the challenge of sharing its knowledge base across its organization.

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Introducing the Architectural Continuum

Organizational design need not be left to chance. Architecture is one way of channeling our vision and building the organization pictured in our mind. Architecture is a tool for mapping the territories of the organization. These territories are the domains of management and organizational design – strategy, structure, process, information, knowledge, culture, and so on. Architecture should not change the content of these domains; rather, through integration each is enhanced and the organization as a whole emerges.

Organizations may be modeled (descriptively and prescriptively) with three types of architecture: *structure*, *process*, and *essential*. Structure describes the physical arrangement of an organization's components. This corresponds to the traditional view of an organization as a machine. Process architecture de-

scribes the behavior of an organization, and has found application with current approaches to process improvement and innovation. Structure and process respectively represent the "classical" and "modern" views of organizations. At the Stevens Alliance for Technology Management Conference on Knowledge Management held at the Picatinny Arsenal (May 31, 2000) we have proposed a third architectural form – the essential architecture that models the cognitive dimensions of an organization. The sequence of architectures – structure, process, and essential – represents (in the given order) an *architectural continuum* of increasing dynamicity.

The architectural continuum is one model to understand the static-dynamic range of architectural models within which organizations invent and operate. Not surprisingly,

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the continuum also represents the historical progression of management processes, from the development of knowledge by relatively few organizational members early in a process (primarily a structural perspective) to real time knowledge creation and application by organizational members who actually do the work (primarily an essential architecture perspective). The management process that describes how knowledge is created and applied is known as *knowledge binding* (Morabito, Sack, Bhate 1999). Below we present a paper adapted from an invited paper we have submitted to IEEE TOOLS'00 (Morabito, Sack, Bhate 2000). This paper introduces the reader to knowledge binding and its characteristics.

Introducing Knowledge Binding

An organization is a *human construction*. So too is each of its dimensions – its structure and strategy, processes and events, information and machines, culture and people, and so on. This means an organization exists as a consequence of knowledge. An organization works because it creates and implements knowledge.

What does this mean? An organization is founded by a person or persons who have an idea – knowledge – on how to do or make something and sell it. They bring their own knowledge to the table. They may also purchase knowledge from external sources (workers, products, or services, etc.) and align it with their own. The knowledge is formulated and subsequently operationalized into a service or product, and into the organization's processes, information systems, structure and so on. *However constructed, an organization and everything in it is human constructed: people and the organization are knowledge creating and knowledge implementing entities* (Novak 1998).

First introduced in *Organization Modeling* (Morabito, Sack, and Bhate 1999), knowledge binding refers to the application of knowledge in a business activity: who applies knowledge, where in a given process is knowledge applied, and when is it applied. The philosophy underlying the level of separation between specification and implementation of a system determines its knowledge binding. Knowledge may be applied *early*, as is typical in industrial-era organizations with largely structural architectures, or much *later*, which characterizes entrepreneurial firms (essential architectures). In the former case, a specification (i.e., knowledge) is applied well before its implementation, while with the latter there is much less separation. In an extreme case, such as an artist painting a portrait, knowledge binding is *real time*: the final "specification" is realized only when the

implementation is fully complete.

An example

We will illustrate the difference between *early* and *late* knowledge binding with an example familiar to us all. An organization may enter into a labor contract with a union. Such a contract, if properly constructed, is explicit and precise, with no ambiguity. The knowledge the contract contains represents a convergence of knowledge made manifest during a negotiating process. Knowledge is made *explicit* and *codified* before the contract takes effect, and in fact, embodies the contract for its life. Each of its particulars is fully specified well before implementation; indeed, many contracts fill volumes and cover several years. In contrast, an employment contract between an organization and a professional is deliberately vague, often nothing more than an offer letter. There may be a few precise particulars, such as a starting salary, but little else. Such a contract is characterized by relatively few precise threads of *explicit* knowledge, either high- or detail-level, and one other dimension – its *tacit* assumptions. In fact, the contract works only because of the *assumptions* each of the parties to the contract shares. These may include the *expectations* of bonuses, career advancement, opportunities for learning, and so on. Not all assumptions and expectations are articulated – most are hidden and *psychological*. Only *during* implementation of the contract are the explicit particulars made manifest, and the tacit assumptions either reinforced or undermined. Such a contract is known as a *relational contact* and is considered largely responsible for organizational success (Kay 1995).

The labor contract is an example of *early knowledge binding*, while the employment contract represents *late knowledge binding*. Each carries with it an assortment of premises and particulars: the lead-time between specification and implementation, total cycle time, the type of work covered by the contract, the type of person doing the work, the organizational structure required to support the work, the type of information system required for the work, and so on. A labor contract is *static* and sufficient for stable markets and information flows, while an employment contract is more suitable for *dynamic* environments. Though organizations require both types of binding, the volatility of 21st century competition favors a shift to late knowledge binding, and with it new working and managing arrangements.

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Knowledge binding is one framework for understanding what both organizational researchers and practitioners are beginning to realize: the distinctive competence of an organization may be attributed to its *process of knowledge construction*, as well as to the contents of its knowledge base. It is no surprise that recent efforts in knowledge management embrace both process and content.

Knowledge binding and organizational design

Early knowledge binding and deliberate design.

Organizational intention is transmitted through a communications channel. The language of the channel is constrained by the organizational domain and character of information that codifies the intention. Such intentions may convey information about an information system, a business strategy, a performance goal, and so on. We call this communication a specification.

For the last century, management and academic researchers (including, recently, computer scientists and information practitioners) have sought schemas to make communications more precise and rigorous. For virtually every domain of the organization (e.g., information systems, strategy, management philosophy, etc.), the trend has been for more analyses, more artifacts, and more elaborated architectures. This is possible only because of early knowledge binding: long lead-time, environmental stability, and the availability of relatively complete information give rise to the time necessary for detailed analysis and design.

For example, in the planning and design of information systems we have progressed from textual descriptions of requirements to elaborated artifacts, such as data flow diagrams, entity-relationship modeling, and so on. More recently, we may communicate even more precisely, with such artifacts as generic associations in information modeling, precise contracts, even a formal specification language such as “Z” (Kilov 1999). With each successive refinement the analysis is more extensive and rigorous, the specification less ambiguous and more detailed, and in practice (though not in theory) the implementation less straightforward. The constructs associated with intricate methodologies, and project management systems are among the artifacts of early knowledge binding.

Let us shift our focus to strategic management. To the casual observer, strategy means “strategic planning.” Such a strategy is known as a *deliberate* strategy – organizational intention carefully planned, analyzed, and implemented. In fact, the strategy formulation

process has progressed from the design to planning to positioning schools (Mintzberg, Ahlstrand, and Lampel 1998). In each successive strategic management approach, the artifacts have become more elaborate to support detailed analysis. In the full blown positioning school, strategic formulation is a formal process with well known strategy constructs such as Michael Porter’s value chain, five force competitive analysis, generic positions, and so on (Porter 1985). In every respect, the progression in strategy formulation has mirrored that of information systems, and in each case, is possible only because of a relatively stable environment, the availability of sufficiently complete and explicit information, and the time necessary for detailed analysis.

Finally, let us look at the parent of all such approaches, *Scientific Management*. Frederick Winslow Taylor introduced Scientific Management a century ago and, according to Peter Drucker (1999), Taylor’s ideas have had more of an impact on the 20th century than any other idea. Central to Scientific Management is top-down management, the scientific analysis of work, and the separation of planning from doing. With this as a foundation, early knowledge binding, with its emphasis on analysis and separation of specification from implementation changed organizations forever. In addition to the approaches presented above, which follow from Scientific Management, management practice itself follows the same precepts. Management by objectives is a common management tool, and what better example of early knowledge binding than a yearly performance appraisal?

Late knowledge binding and emergent design. It is apparent across all domains that organizations have characteristically elaborated their analytical artifacts and management processes. The common thread in organizational design and management has been this progression to *systemized elaboration*. It is most easily seen in elaborated management processes and organizational structure (both hierarchical and horizontal structures, where the latter is a modification of the former with little substantial difference in knowledge binding). This is the way organizations have worked for the past century – with architectures that are largely structural.

The shift to global markets, the increasingly dynamic knowledge content of products and services, and the breakdown of long-term employment relationships has changed the context of knowledge binding. Organizations have responded with a shift to more bottom-up, dynamic processes that leverage the expertise of all

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their workers. This new context is represented by essential architecture of organizations.

For example, Earl (1993) has demonstrated that shared meaning in information systems planning is far more important to an organization's competitiveness than the analytical rigor of traditional approaches (e.g., information engineering). While the latter includes extensive artifacts of analysis and design, the former uses a "soft" organizational approach where common understanding and themes are emphasized.

Virtually every organizational domain is shifting from early to late knowledge binding. In software development, a "unity" of analysis and development (e.g., cluster model) is replacing the "waterfall" model (Meyer 1995). The learning school of strategy is now emerging to share the spotlight with the positioning school (Mintzberg, Ahlstrand, and Lampel 1998). The organization's value chain is disaggregating into a network organization – a web of dynamically assembled sub-organizations of knowledge workers and groups.

In every respect, the organization is embracing some variant of late knowledge binding in order to address the business requirements of dynamic knowledge creation, increasingly wider sources of knowledge, continuous knowledge flows into products and services, and so on and so forth. Moreover, knowledge binding may even be real time: consider stock brokers who have access to the same data and information and who make very different recommendations – a consequence of real time application of tacit knowledge borne of experience and education.

Assumptions and implications of knowledge binding and organizational design.

The division of labor is considered the most efficient way of organizing production. Historically, it has been used to operationalize the knowledge of an organization's leaders or domain experts, and embodies the concept of early knowledge binding. Moreover, an organization's management processes exist to enforce early knowledge binding by reducing

human variance (i.e., application of individual knowledge) and promoting conformance throughout its division of labor. With late knowledge binding, the division of labor does not go away; rather, it becomes a source of knowledge as well as an implementation vehicle. Similarly, the management processes that enforce knowledge binding also change. Such management processes shift from

| Organizational Dimension | Early Knowledge Binding | Late Knowledge Binding |
|--|--------------------------|--------------------------------|
| Environment | Static | Dynamic |
| Uncertainty & ambiguity | Low | High |
| Decision making | Centralized | Decentralized |
| Management process | Top-down | Bottom-up or middle-up-down |
| Planning horizon | Long | Short |
| Cycle time | Long | Short |
| Lead time between specification and implementation | Long | Short |
| Knowledge type | Explicit | Explicit & tacit |
| Knowledge strategy | Convergent | Divergent |
| Degree of freedom | Constrained | Creative |
| Knowledge source | Top of division of labor | Throughout division of labor |
| Number of participants | Few | Many |
| Information requirements | Complete and known | Incomplete and not fully known |
| Architecture & artifacts | Elaborate & extensive | Simple & few |

Table: Organizational Dimensions and Knowledge Binding

promoting routinization and machine-like behavior (e.g., a machine bureaucracy) to promoting adaptation and individual knowledge creation and application (e.g., empowerment). Such newly created knowledge is increasingly strategic as well as operational. Moreover, the division of labor is increasingly embodied, not in a hierarchy, but in a network of knowledge domains that exploit the economies of scale and quality associated with expertise.

The central theme is straightforward: early knowledge binding is distinguished by the creation of knowledge by relatively few people, typically senior managers or domain experts. That knowledge is subsequently operationalized through the division of labor. In contrast, late knowledge binding requires the accumulation of knowledge from the division of labor, with rapid, or even a unity of implementation.

Early and late knowledge binding need not be separate; in fact, Nonaka and Takeuchi (1995) have rec-

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ommended a best-of-both-worlds approach to management: the middle-up-down management process. In this approach middle managers are considered "knowledge engineers", whose members mediate strategic intent from the top (early knowledge binding) with real-time knowledge from the line (late knowledge binding). This stands in sharp contrast to most traditional firms who consider middle managers "information relays", a legitimate perspective in the case of early knowledge binding.

Early knowledge binding favors a business rule approach to management, whereas late knowledge binding lends itself to alternative scenario development and the employment of heuristics. The shift from early to late knowledge binding is appropriate in today's unpredictable and difficult business environment. Management requires elastic thinking that breaks the rules of traditional organizational life. This means experimentation, learning, and human empowerment.

Advantage now extends beyond price and position to cognition. Twenty-first century management requires the informed judgment, sense making, and the imagination of every member of the organization – the foundation of an organization's essential architecture. The thrust of late knowledge binding will have to be woven into the fabric of existing early knowledge binding structures. In the pursuit of competitive distinctiveness, we expect to see knowledge binding and the whole process of knowledge construction rise to the top of management's agenda.

As a summary, the table on page 6 compares early and late knowledge binding with a variety of organizational characteristics. This listing is comparative and illustrative, not complete – virtually every process and routine of an organization impacts, and is impacted by, knowledge binding.

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