Information technology provides knowledge management capabilities that were not possible before. Systems integration that incorporates true knowledge management thinking offers the IT department a leadership opportunity for organizational transformation in partnership with the rest of the enterprise.

System integration and knowledge management share common objectives: making organizations more competitive, more effective and efficient, more agile, more responsive to market and supply-chain changes, and more innovative.

The knowledge organization and the learning organization concepts have only blossomed at the forefront of the management literature in the last five years, although learning and knowledge have been the property of human-kind since its early beginnings, millions of years ago. Development of the knowledge organization is the result of interactions among a number of main factors: the increasing complexity and rate of change in business environments, the acceleration (or explosion, as some would say) occurring in the development of new knowledge, the democratization of knowledge through such networks as the Internet, and a deeper understanding of what organizational life and management are all about.

The business world is more complex today. The number of factors at play is larger, and they change faster. Information is abundant and volatile. Globalization, information technology, communications systems, and an explosion of knowledge are all contributing to this new complexity.

To keep pace with the environment, business managers must learn as quickly as it changes, and to be competitive, they need to know some things in more efficient ways than others in a given industry. The value the organization delivers to customers at a given moment depends on what it knows as an organization at that time. In parallel, the organization already knows new projects that it is trying to implement by changing products, services, and processes. The concepts of management, strategy, leadership, systemization, product innovation, process design, culture, learning, and competitiveness have all matured to a new level of understanding, that of the knowledge organization.

Information technology (IT) is a powerful enabling factor for capturing the organization’s knowledge, sharing it, and “synergizing” it internally and for accessing others’ knowledge externally. There must, however, be a proper architecture of hardware, software, networks, and applications integrated with the fabric of the organization, its business processes, and its organizational life. Systems integration has been defined as “the melding of divergent and often incompatible technologies, applications, data business processes, and communications into an enabling and uniform architecture and functional structure.” System integration seems to evolve in organizations through four stages:
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Stage 1: Interconnectivity
Stage 2: Interoperability
Stage 3: Semantic consistency
Stage 4: Convergent integration

System integration is recognizing that any entity (e.g., a group, a department, or a plant) is a system made up of numerous components (see Exhibit 1) that must work in harmony if top performance is to be achieved.

Any organizational entity is full of knowledge. Formalizing knowledge management, however, is just recently becoming a concern in businesses. It reflects a certain level of advanced maturity, mostly in large organizations. Young organizations are more concerned with getting their operations to run smoothly than with formalizing the management of their knowledge. In small organizations, knowledge is for the most part tacit and is shared and developed through direct, informal contacts.

This interest in formalizing knowledge management is a logical step in the maturing of organizations and their management and in the evolution of IT and its application within organizations.

This article first presents the basic concepts associated with knowledge and knowledge management in organizations. Then, it focuses on how systems integration efforts should contribute to the building of the knowledge organization.

KNOWLEDGE CONCEPTS

Knowledge has been a concern of philosophers for thousands of years, and a source of much debate, but only in the last few years have managers become generally interested in the concept. The approach in this article is a practical one, steering away from any semantic discussion or philosophical analysis.

To facilitate the discussion, data, information, and knowledge are defined as follows:

- **Data.** Raw facts, not interpreted.
- **Information.** Phrases or images (e.g., graphs) that provide the results from analyzing and interpreting data; phrases or images that carry meaning.
- **Knowledge.** Things that are held to be true in a given context and that drive people to action if there are no impediments.

Knowledge is what drives many of people’s behaviors. It evolves continuously as they learn through interpretation of what is presented to them and what happens to them every day.

EXHIBIT 1 Components of the Organizational Entity

- On what
- When
- How
- In what context
- Resulting in what
- For whom
- Why
- By whom
- With whom
- With what
- Where
Problems occur when people’s behaviors are not in harmony with what they “know.” Impediments to aligning actions with knowledge can come from, for example, a lack of external support or resources, the fear of failure or sarcasm, insufficient motivation, or lack of the will to leave the existing set of comfortable behaviors.

**Value of Knowledge**

It is agreed that, in general, knowledge is valuable, but how is that value measured? Certainly, not all knowledge has the same weight. The worth of any piece of knowledge is a function of context, applicability, and usefulness. The questions to ask is: Is it critical, necessary, or sufficient? Critical knowledge includes the deadline for a proposal to a customer, special promotions by key competitors, and quality trends in a particular manufacturing process. Criticality depends on vantage point and timing.

Another perspective is the cost of not knowing (i.e., ignorance), not using existing knowledge, or not developing new knowledge. Organizations lose opportunities to address new customers’ needs. They are outmaneuvered by competitive moves or incur a deficit in innovation in products or processes. An organization loses knowledge when an employee leaves, and therefore the organization has to develop that knowledge twice.

**Types of Knowledge**

This section distinguishes among three basic types of knowledge: explicit, tacit, and embedded or habitual. Normally, only the first two are discussed in the literature; however, this chapter supports the premise that embedded knowledge is a significant component of organizational knowledge.

Explicit knowledge is expressed in facts, phrases, drawings, and images. It can be documented on paper or in electronic form and can be circulated. Explicit knowledge facilitates continuity and transfer of know-how, serves as a memory jogger, and ensures uniformity of transmission.

Tacit knowledge is a personal thing, comprised of internal meaning structures, mental models, experiences, insights, intuition, and hunches. It is tinted by beliefs and emotions. Two types of tacit knowledge can be distinguished. One is technical, related to the deep know-how of the expert, and the other, in the cognitive dimension, consists of schemata, mental models, beliefs, and perceptions. In the end, tacit knowledge (most of it subconscious) is what guides people’s daily actions and behaviors.

Embedded knowledge underlies the existing infrastructure of plants, equipment, information systems, and work processes. The importance of that knowledge is seen when a key employee who “knew” how and why things were a certain way leaves and a breakdown occurs. Some old information systems that have become a “spaghetti” of codes without documentation are good examples. The problem in many enterprises arises when embedded knowledge is not explicit anymore, and the single owner of the tacit knowledge associated with it has left the company. A lot of automatic behaviors in people (e.g., driving a car) could be labeled as embedded knowledge.

Embedding knowledge means making knowledge less dependent on people or groups by integrating it into information systems, business processes, and infrastructure (e.g., buildings, equipment, and floor layouts). Within software, this could be accomplished through expert modules that incorporate rules, documentation of logic, assumptions, actions done, reasons, and explanations. Communication systems can incorporate routing and distribution logic to transmit information automatically to people who should know.

**Levels of People Knowledge**

Five “levels” of people knowledge can be distinguished in organizations: individual, teams, geographical units, affinity networks, and enterprise. Above the individual level, knowledge consists in the collective, meaning structures that exist among the group. These structures “are those which organizational members hold jointly with other members of the organization” and include norms, strategies, and assumptions that guide how work is organized and conducted. The five levels intermingle, and knowledge typically flows back and forth as it is shared, reused, confronted, challenged, rejected, and ignored. In addition, everyone has a personal knowledge network that extends outside the organization boundaries. The organizational knowledge network is vast and complex, a real “web” by itself.

**Knowledge Acquisition and Creation**

New knowledge is typically acquired by reading, listening to someone, observing, experiencing events, or thinking. First, knowledge is about internal “meaning structures” in people’s minds. A book on someone’s desk is useful
organizational knowledge to the extent that people have
- internalized the information and facts contained in it
- learned new skills from it
- developed new paradigms
- modified their internal meaning structures

Transferring knowledge from one person to another requires that tacit knowledge be converted into explicit knowledge through experience sharing, dialogue, discussions, know-how "exteriorization," and teaching. Tacit knowledge is also transmitted and learned directly as tacit knowledge through observation and practice.

Knowledge is the fruit of learning and thinking. Moving to a new level of knowledge requires letting go of current meaning structures to adopt and integrate new ones.

The process of organizational knowledge creation starts when an idea is expressed by an individual and shared with other people. The idea is triggered by some external information, a discussion, observation of the workplace, or reflection on a problem or situation. The idea is discussed, modified, and shaped through contacts with others and an exchange of their tacit knowledge. Eventually, the idea expands to other levels and groups and to the whole organization. Finally, if accepted, it becomes embedded in the fabric of the organization, as a new or improved product and service or a revised business process or procedure, for example. In creating new knowledge, people use metaphors (i.e., images and symbols) and analogies (i.e., comparisons) to express new views and ideas. All new knowledge in organizations must become tacit knowledge within people and embedded in the "infrastructure" to translate into new consistent behaviors.

The Knowledge Organization

The knowledge organization (KO) values knowledge, is aware of what it knows and needs to know, protects and fully uses its available knowledge, stimulates the development of new important knowledge, and remains aware of the evolution of external knowledge. The KO is also open to outsourcing certain tasks, processes, or functions to other organizations that have better knowledge or performance in a particular area.

The KO is aware of its knowledge and its value, and each organization has a unique profile. Four perspectives determine criticality of knowledge: strategic, tactical, operational, and project-related. Customer preference is important knowledge for delivering top-of-the-class service on a day-to-day basis. Customers' seasonal behaviors guide warehouse stocking levels for different products. Understanding the corporate vision and ideals helps detection of long-term opportunities and decision making. Finally, management knows how a project is progressing through regular status information. Further examples are presented in Exhibit 2.

Organizations are interested in a vast range of topics or "objects." Outside objects of interest include customers, markets, vendors, competitors, industry, governments, regulatory agencies, regions and countries, domains of technology, and trends. Internal objects include vision and plans, products and services, channels, people, processes and procedures, policies and standards, equipment, buildings, quality levels, stocks, sales, profitability, risk factors, and projects.

The Four Pillars of the Knowledge Organization

Becoming and remaining a KO is a multidimensional effort that addresses organizational beliefs and commitment, organizational form, people know-how, and IT knowledge support.

Organizational Beliefs and Commitment

Whatever the level considered (e.g., group, department, division, or whole organization), the management team of that entity must understand what a KO is, believe in its power and value, and commit to the personal and organizational effort required to become one. The management team must believe that knowledge is the strongest competitive advantage in the long term and understand that true organizational knowledge resides in tacit form, in individuals, who are the real sources, keepers, and developers of organizational knowledge.

In addition to committing the organization to the process of learning and becoming a KO, management must communicate the vision of the future and the ideals pursued. These provide the roots on which knowledge must grow. Senior management has a unique view of the whole organization and its complex environmental context, which it must share with the organization through directions and boundaries. This view is enriched by knowledge generated within the organization in a continuous process of exchange. People require incentives to shake out their paradigms and to renew themselves. Impediments to learning and action must be identified and eliminated. Typi-
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EXHIBIT 2 Management Perspectives and Examples of Knowledge Management

<table>
<thead>
<tr>
<th>Perspective</th>
<th>Examples</th>
<th>Knowledge Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational</td>
<td>Customer profile</td>
<td>Information systems and business</td>
</tr>
<tr>
<td></td>
<td>Credit rules</td>
<td>infrastructure</td>
</tr>
<tr>
<td></td>
<td>Delivery schedule</td>
<td>People's attitude and tacit knowledge</td>
</tr>
<tr>
<td></td>
<td>Manufacturing procedures</td>
<td></td>
</tr>
<tr>
<td>Tactical</td>
<td>Competitor tactical moves</td>
<td>Corporate knowledge database</td>
</tr>
<tr>
<td></td>
<td>Seasonal market factors</td>
<td>Expert systems and rules</td>
</tr>
<tr>
<td></td>
<td>Temporary help hiring plan</td>
<td></td>
</tr>
<tr>
<td>Strategic</td>
<td>Market trends</td>
<td>Corporate knowledge database</td>
</tr>
<tr>
<td></td>
<td>Business goals and vision</td>
<td>People's tacit knowledge</td>
</tr>
<tr>
<td></td>
<td>Competitor strategic moves</td>
<td></td>
</tr>
<tr>
<td>Project</td>
<td>Project status</td>
<td>Project database</td>
</tr>
<tr>
<td></td>
<td>Project schedule</td>
<td></td>
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<tr>
<td></td>
<td>Issues</td>
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</tbody>
</table>

People Know-How
People know-how can be grouped under three headings: human resources management policies and systems, individual capabilities, and new knowledge-related roles.

Human Resources Management. These policies and systems require major adjustments throughout: reduction in number of different jobs, simplification of job descriptions, new criteria for hiring and promotion (including the search for increased diversity), frequent personnel movements, team- and knowledge-favoring incentives, labor relations, career planning, and training and development.

Individual Capabilities. Because knowledge starts at the individual level, building individual capabilities is a major requirement for becoming a KO. Understanding knowledge, knowledge management, and personal and organizational change are prerequisites. People must feel a climate of trust to freely share their knowledge. They must be open to new ideas and also trust their own tacit knowledge. They may require new skills in such areas as personal and organizational learning, creative and effective thinking, assumptions surfacing and testing, interpersonal relations, group and team work, development of affinity groups, and use of IT enablers. Assumptions are a major driver of people behaviors. Surfacing assumptions and validating them against reality should be part of the culture of a KO.

Knowledge-Related Roles. In the KO, new knowledge-related roles must be assumed. The
Knowledge strategist role belongs to senior management to ensure that critical knowledge is nurtured and grown, and that a true KO emerges. At the other end of the spectrum are knowledge technicians who understand the business of users, develop knowledge models, coach people in becoming better knowledge builders, identify opportunities for embedding knowledge in systems, and provide assistance in using the knowledge-embedding tools (e.g., expert modules with rules).

**IT Knowledge Support**

The literature on knowledge management and organizational learning talks very little of IT and its enabling power for the KO. The reality is that many organizations are capitalizing on innovative and complex applications of IT to gain a significant knowledge advantage, either for competitive market positioning or for productivity and service response gains.

Continued developments in enterprisewide software, point-of-sale processing, networking, client/server hardware, personal workstations, communications and the Internet and intranets, expert systems, knowledge-based systems, voice processing, groupware, computer-based linguistics, imaging, and optical character recognition have led to powerful opportunities for the KO. The following are some specific applications for the KO:

- Real-time integrated business-process-oriented software implements cross-functional barriers in a seamless fashion, using common data and meanings, with expert modules attached to capture and reapply systematically rule-based knowledge.
- Intelligent document processing captures, interprets, classifies, organizes, stores, and circulates "paper" information.
- Hypertext-like knowledge databases with metamodel foundations are integrated with the business databases and are easily accessible to everyone.
- Workflow management tracks and routes information.
- Sophisticated communication systems include electronic mail, intelligent phone systems, groupware to support communication, creative work and discussions between a group of persons, videoconferencing to facilitate face-to-face distance meetings and exchanges, and bridges to the Internet and to electronic information bases to access the expanding store of world knowledge.

Workstation-based performance and learning support tools include systemic modeling and scenario-building tools for exploring new ways of operating and documentation tools that formalize know-how and assumptions, formulate new concepts and principles, and identify measures to monitor and verify assumptions.

The creative application and combination of these IT solutions can facilitate how tacit knowledge within individuals is shared and “synergized” with that of others and how it grows through additions from experience, new combinations, and external explicit knowledge.

For systems integration, the challenge becomes one of managing complexity, diversity, rapid evolution, processing power, security, and massive storage requirements. Senior management beliefs and commitment to the KO concept ensure that proper resources are made available for systems integration work.

**Knowledge Management in Organizations**

The purpose of knowledge management in organizations is to ensure growth and continuity of performance by protecting critical knowledge at all levels, applying existing knowledge in all pertinent circumstances, combining knowledge in synergistic ways, acquiring relevant knowledge continuously, and developing new knowledge through continuous learning that builds on internal experiences and external knowledge.

Knowledge management tasks should include:

- Identifying critical knowledge.
- Assessing vulnerabilities and weaknesses.
- Externalizing (or making explicit), capturing, and protecting critical knowledge.
- Reusing and leveraging existing knowledge.
- Building learning capabilities.
- Monitoring the evolution of knowledge in the outside world.
- Acquiring pertinent knowledge from outside.
- Stimulating the development of new knowledge to achieve the vision and ideals.

Whether concerning individuals or groups, adopting new meaning structures and modifying associated behaviors require time and effort.
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INTEGRATING KNOWLEDGE MANAGEMENT INTO SYSTEMS INTEGRATION

Organizations today are facing rapidly changing realities. The dynamics are illustrated in Exhibit 3. As technologies, especially IT, change and mature, companies are exploiting them to offer new levels of service and quality to the market. At the same time, the marketplace is changing through globalization, sophistication of customers, and demographics. All these translate into new business requirements to which industry leaders respond by using technology and system integration solutions. These continuous dynamic interactions keep on modifying the world in which all organizations evolve.

Organizations in fact use much more than just technologies. They especially use knowledge of the marketplace combined with their know-how to deliver value that customers appreciate. They grow their knowledge to innovate in their products, services, work processes, and competitive moves. Efficiency, speed, and synergy are greatly facilitated by the effective use of IT. Studies done in the 1980s concluded that IT had added little value to enterprises. On the other hand, recent studies have shown that IT has brought a great deal of value to customers and changed the rules to be successful in the marketplace.

In today’s context, system integration must incorporate knowledge management in its need analysis and architectural work. Instead of nice-to-have add-ons, communication and knowledge support applications must be designed as integral components of the whole solution. Databases must shift to becoming true knowledge bases. New solutions (e.g., imaging, expert systems, artificial intelligence), previously considered blue-sky, have become possible due to better functionality and economics.

System integration must still be grounded in the vision and strategies of the business. Today, IT acts more and more as the true, real-time, integrated nervous system of the enterprise. Without it, many organizations would just come to a full stop. The system integration effort must be fully meshed with the total rethinking of the organization. Many variables are involved, as shown in Exhibit 4.

IT systems are playing a larger role as the memory and mind of the organization. Evolution in expert systems and in textual analysis is bringing to organizations new capabilities in automated handling of information and “intelligent” behavior. IT systems can stimulate the process of knowledge sharing and development. Many innovations associated with the Internet (e.g., hypertext navigation and information search agents) are now arriving on desktops. Another paradigm shift may be under way, created this time by people outside of the traditional information systems corporate world.

What specific tasks are required in the system integration process to reflect a knowledge management perspective? The following is a suggested list:

- Preparing the team:
  - obtaining senior management commitment
  - preparing the project team for knowledge management tasks; familiarizing team members with knowledge concepts and giving them training in knowledge management processes and practices and such soft skills as facilitation, listening, and coaching
  - developing a knowledge management environment for the team that includes a
knowledge-sharing culture, teamwork, overlap of roles, open work space, and an IT infrastructure
- developing organizational learning allies and capabilities throughout the enterprise

Understanding business goals, vision, strategy, and environment:
- identifying areas of knowledge critical or important to the future of the business
- understanding how that knowledge is acquired, developed, maintained, shared, and reused

Defining business processes:
- identifying critical or important knowledge to flow with each main business process
- identifying the required knowledge about business processes themselves (e.g., for sharing of best practices)
- designing knowledge-handling and -supporting processes and practices, such as monitoring, searching/mining, access, capture, conversion, interpretation, filtering, development, organization, storage, embedding, security, sharing, communication, archiving, and destruction

Defining applications and user requirements:
- integrating knowledge aspects into application design
- specifying user interface and navigational capabilities requirements, including graphical user interfaces, multimedia, and hyperspace
- identifying specific applications for knowledge processing and sharing

Designing knowledge and data architecture:
- developing a knowledge metamodel specific to the business
- identifying the many different forms that knowledge may take, such as diagrams, whole documents, 3D images, video and sound documents, and dynamic visuals
- transforming data architecture into knowledge architecture

Designing technical architecture:
- defining principles and standards to facilitate technical evolution as the IT industry offers new capabilities
- defining new principles and standards for processing of knowledge
- incorporating software, hardware, and network solutions to meet knowledge-processing requirements

Prototyping and implementing:
- setting up pilot and demonstration projects to facilitate organizational learning and build organizational commitment and support

Learning and improving:
- regularly assessing progress and value of effort
- extracting lessons from experience acquired and sharing them
- improving approaches, processes, and tools
- modifying policies, organizational forms, rules, and views

THE IT DEPARTMENT AS A KNOWLEDGE ORGANIZATION

The IT department is at the junction of two very dynamic worlds: that of the business that it serves and that of the IT world that provides...
the enabling forces. It also has, in some organizations, a credibility problem, because of historical delivery and reliability problems. The knowledge era offers new opportunities and challenges.

As in the past, the IT department must understand its clients (i.e., the business people) and see their needs through new eyes. The IT department executive should be an integral part of the business executive team if the ever-expanding capabilities of IT are to be a significant factor in designing the vision and strategies of the business.

Managers are learning to deal with the new business complexities and changes; so must the IT community and its management and professionals. They need to change some of their paradigms radically. IT customers within organizations are becoming sophisticated users of technology, and they want IT enabling immediately. Desktop computing has democratized access to IT solutions, and some users have taken the plunge wholeheartedly. Whole business solutions come shrinkwrapped, ready to install, although this is easier said than done, because of the massive effort of organizational alignment required. The hardware picture has become more complex and changed drastically to include multilevel computing and networking and the accompanying new problems of security. In addition, a frenzy called the Internet has captured the world, instantaneously democratizing the publishing of and access to vast amounts of knowledge.

The IT department has a unique role in monitoring the evolution of IT capabilities offered by the industry. This technology watch is critical, as new products suddenly make it economically feasible to accomplish knowledge-processing tasks previously believed to be unique to humans. The challenge is for "traditional" information system thinking to evolve at the speed of change in the IT world and for sound judgment to discriminate between valid and false promises.

The IT department should assess whether it is itself a KO. Do IT managers know what the department knows and what it needs to know? What are the critical areas of knowledge for the department regarding the whole enterprise and its environment, users, the IT department, and the IT environment? How should knowledge of the department be managed? Is the culture conducive to being a true KO? What is the gap? What is the plan to transform the IT group into a KO? Should outsourcing be used as a strategy for some dimensions?

The IT department also has the opportunity to become a knowledge center of expertise for the whole organization in the domain of knowledge management. Key responsibilities of such a center include:

- familiarizing the organization with the concepts of knowledge and knowledge management
- coaching the organization in the process of becoming a KO
- understanding and influencing corporate direction in the area of knowledge management
- developing a system integration design that incorporates a knowledge perspective throughout
- designing and installing easily accessible knowledge "warehouses" and knowledge-sharing networks
- maintaining the knowledge metamodel
- finding, testing, adapting, and implementing IT knowledge support applications and tools
- coaching users in becoming more knowledge-savvy
- providing technical knowledge management support

SUMMARY

In the pursuit of their common objective, the fields of knowledge management and system integration need one another to blossom and be true enablers of organizational success. Knowledge management is a new field that must be learned throughout any organization. Knowledge exists in human beings, whether they are IT specialists or IT users. Both communities need to become more knowledge-oriented, learning how to learn, to use their knowledge better, and to grow new knowledge. Only when both have developed a common knowledge and knowledge management structure will the organization benefit from a renewed partnership.

Information technology provides knowledge management capabilities that were not possible before. System integration that incorporate true knowledge management thinking offers the IT department a leadership opportunity for organizational transformation in partnership with the rest of the enterprise.

Note

This article is a chapter in Auerbach’s forthcoming book, *Enterprise Systems Integration*, available in late 1999.