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Space Workforce Education in the Year 2000: Knowledge Management Concepts and Issues

Patrick Simpkins

Introduction

Education in today's world isn't just about children and young adults going to places of learning. It is more about capturing knowledge and sharing it in a myriad of ways with others. Knowledge is defined throughout history in the literature a variety of different ways. Knowledge and the concept of knowledge management should be further defined so that application and impact can be better understood. Definitions of knowledge are plentiful but not necessarily clear cut. "Knowledge" can be defined as the understanding of why and how something works. It is not data or information. Implicit knowledge, in one sense, is that which is highly personal and hard to formalize. Subjective insights, intuitions and hunches fall into this category. Another definition of knowledge is simply stated as information combined with experience, context, interpretation, and reflection (Davenport, DeLong, Beers, 1998). Perhaps the most cited and influential distinction of knowledge types is Polanyi's identification of two aspects of knowledge: tacit and explicit. This is a distinction he aligns with the "knowing how" and the "knowing what" of Gilbert Ryle (Nahapiet, 1998). Explicit knowledge is very clear and can be communicated quickly and easily. Explicit knowledge is that which is written down or expressed in some tangible form. Research reports, simple software code, and test results are all examples of knowledge that tends to be explicit. Tacit knowledge, in contrast, requires a high degree of interpretation; it can't be transferred quickly and easily. Scientific expertise, product technologies, and operational know-how are typical of tacit knowledge.

The definition of knowledge management is also not clear-cut. Fundamentally, knowledge management is a set of processes for transferring intellectual capital to value-processes such as innovation and knowledge creation and acquisition, organization, application, sharing, and replenishment. The sum total of the experience and brainpower of its people, its products and processes, and its clients is the enterprise's knowledge. In many organizations this knowledge is not formally structured for use, or thoroughly tapped, which is a problem when the intellectual capital is a crucial component whether it is an enterprise's core business or a private or public space program. Knowledge management is a strategic, systematic program to capitalize on what an organization knows (Knapp, 1998). Another approach is to view knowledge management as the concept under which information is turned into actionable knowledge and made available effortlessly in a usable form to the people who can apply it (Angus, Patel, Harty, 1998). This definition applies particularly well in the area of education of both academics and industries. The most valuable knowledge is often not that which is encoded as information. It is human expertise and the processes by which it is shared and enhanced that create value through new products and services and enhanced business processes (Skyrme, 1997).

Our educational institutions are built and managed around the concept of capturing and transferring knowledge to students. Space related public organizations around the world constantly pursue the capture and dissemination of knowledge in the never-ending pursuit of "faster, better, cheaper". Knowledge has been recognized as a valuable resource by economists (Nahapiet, 1998). Last year, Delphi Consulting released results in which businesses

expect to spend \$5 billion on knowledge management activities by the year 2000. This same study also reported that knowledge management activity would grow 79 percent this year, while 77 percent of the respondents are planning for knowledge management by 1999. The knowledge management tools industry is expected to have \$500 million in revenues in 1998 (Smith, 1998). The business world is becoming so concerned about knowledge management that, according to one report, over 40 percent of the Fortune 1000 now have a chief knowledge officer, a senior-level executive responsible for creating an infrastructure and cultural environment for knowledge sharing (O'Leary, 1998). For these and many other reasons, it is of ultimate importance that organizations manage the knowledge of their employees and educational institutions take advantage of the lessons learned in the process.

For a myriad of reasons some analysts estimate that most workers use only a small fraction of what they know (Ash, 1997). Unfortunately, many companies have confused information with knowledge and are not developing knowledge strategies (Clarke, 1998). But unless they have captured the knowledge of their employees this can result in a loss of critical information. The effects of the dissipation of knowledge, through downsizing or other means, are decreased quality, teamwork, productivity, and innovation. The business problem that knowledge management is designed to solve is that knowledge acquired through experience doesn't get reused because it isn't shared in a formal way (Angus, Patel, Harty, 1998).

Concepts and Analysis

Although there are emerging themes in this field, every company is doing knowledge management different. Two knowledge-related aspects are vital for viability and success at any level. They are knowledge assets and knowledge related processes (Wiig, 1998). In people and in organizations of all kinds, knowledge must be managed effectively to ensure that the basic objectives are attained in the most effective and efficient way. In this context, knowledge management in organizations must be considered from three perspectives with different horizons and purposes. These are a business perspective, a management perspective and a hands-on operational perspective. The business perspective concerns corporate strategy and deployment of knowledge assets. The management perspective is the facilitation, monitoring, and creation of knowledge policies and practices. The hands-on operational perspective includes the tools and training required (Wiig, 1998).

Sharing of knowledge is suggested by Nahapiet (1998) to come about in two main ways: (1) through the existence of shared language and vocabulary and (2) through the sharing of collective narratives (Nahapiet, 1998). A shared language enhances combination capability. Narrative in the form of stories, full of seemingly insignificant details, facilitates the exchanging of practice and tacit experience between technicians, thereby enabling the discovery and development of improved practice. The emergence of shared narratives within a community thus enables the creation and transfer of new interpretations of events, doing so in a way that facilitates the combination of different forms of knowledge, including those largely tacit.

Knowledge management is multidisciplinary and draws on aspects of information science, interpersonal communications, organizational learning, cognitive science, motivation, training, and publishing and business process analysis. It is not solely about technology, but it requires the integration of other existing information systems. Leveraging intellectual capital requires attention to structures and attributes that must be in place for a successful knowledge management program. An organization must ensure available knowledge provides value, a learning attitude is in place, a trusting culture, trying to measure knowledge management effects, and deploying the right tools (Knapp, 1998). The system objectives that support the knowledge-management goal are knowledge gathering, organizing, refining, and distributing.

Each of those objectives has a host of enabling functions. Knowledge organizing, for example, happens through searching, filtering, cataloging, and linking, to name a few. Technologies (products or features of products) combined with business practices make these objectives achievable (Angus, Patel, Harty, 1998). In organizations, efforts to improve awareness of knowledge management should precede more formal, structured programs for building repositories. At one consulting firm, capturing structured and unstructured knowledge and improving access were objectives for a portfolio of projects, which included the development of an expert network and the creation of internal document repositories and unstructured, lessons-learned knowledge bases (Davenport, DeLong, Beers, 1998).

While capturing knowledge is the objective of the knowledge repository, other projects in a research study of thirty-one companies carried out by Davenport and others focused on providing access to knowledge or facilitating its transfer among individuals. These projects recognize that finding the person with the knowledge one needs and then successfully transferring it from that person to another are difficult processes (Davenport, DeLong, Beers, 1998). Certainly, the capture and transfer of knowledge in the aerospace industry is key in education the workforce of the future. Many variations were found among the thirty-one projects. They involved many different types of knowledge, from R&D to sales to production. Some were self-funding, using a market-based approach that charged users for knowledge services. Others were funded from overhead. Some took a hybrid approach, for example, relying on corporate funding during the early phases but requiring a transition to self-funding over time. Some projects were managed or coordinated by a centralized corporate knowledge management function, while others occurred in a more bottom-up, decentralized fashion.

Turner (1998) states that certain issues or concerns must be addressed prior to implementation of a knowledge management system. These are determining what information is useful for making critical decisions and perhaps, in the private realm, preserving corporate intellectual assets, and developing a company-wide meta-data model based on the kind of information to be managed and the way it will be used. One important concern is the demand for clear definitions that all of those responsible for entering, storing or retrieving information in the system can understand and agree upon. Additional factors include clearly defining who enters which type of data where and when, developing a security architecture that is appropriate to how the business will use the information, and deploying easy-to-use desktop interfaces whenever possible to help users fend for themselves rather than rely on a central report-generation organization. The information usage should be monitored and the information management strategy should be adjusted accordingly. Finally train users, get senior-level support every step of the way, and then invest in global software packages, database migration and infrastructure upgrades (Turner, 1998). With these concerns in mind in the development of a knowledge management system, the education of a workforce can be greatly enhanced at a time when information is being generated at an ever-increasing pace.

The literature generally identifies seven steps to follow when implementing a knowledge management methodology in an organization. The first is to identify the problem. Corporate as well as public organization knowledge is typically stored in isolated systems or knowledge "silos". As a result of the access and technological barriers protecting this knowledge, users perceive that there is a lack of information. The knowledge segments should be identified. The next step is preparing for change. Change in the form of new lines of business or new ways of dealing with space workforce issues as well as how those issues are addressed. The third step is to create the team. Most organizations that have successfully implemented knowledge management have created a corporate-level knowledge management team that is charged with

and responsible for implementing a pilot project. The fourth step is to create the knowledge map. Once the map of knowledge is clear, define and prioritize the key features that can be implemented by the technology chosen. The fifth step is to ensure that the knowledge management system can provide feedback to management on how the system is being used and to highlight any difficulties. The sixth step is to define the building blocks for a knowledge management system. The base structures of a viable knowledge management system should consist of a knowledge warehouse, knowledge contribution and collection processes, knowledge retrieval systems, a knowledge directory, and content management. The seventh and final step is integrating existing information systems. Companies have always tried to organize knowledge; they write handbooks, maintain files, provide training, and collect data (Stewart, 1998). Typical knowledge management initiatives include the creation of knowledge databases, active process management, development of knowledge centers, introduction of collaborative technologies, and knowledge webs (Skyrme, 1997).

Growing availability of telecommunications has offered technologies like distributed systems and client server architecture that facilitate the process of empowerment of the lower levels. In the informed organization, workers would be "empowered" by virtue of access to necessary information to perform higher-level tasks. Decisions relating to "soft" information would be delegated to the "grass roots" where there is easy access to relevant information generated within the system by means of "cheap" internal information systems. Indirect communication would be preferred for well-structured information for routinized, "preprogrammed" decision processes.

Knowledge repositories are widely recognized as a key component of any knowledge management system. Because they are so different, tacit knowledge and explicit knowledge require very different kinds of transfer mechanisms. The exchange of tacit knowledge requires face-to-face communication. Strong links, such as meetings, training sessions, and apprenticeships, are required to transfer tacit knowledge. The exchange of explicit knowledge can usually be completed through purely electronic means, without face-to-face contact. The focus of successful knowledge management programs is to make this implicit knowledge about organizational knowledge 'explicit', and to put in place systematic processes that identify it, develop it, share it and exploit it. Tacit knowledge is communicable through mechanisms like observations, conversation, on-the-job learning and so on. Its very intangibility makes its management a challenge (Skyrme, 1997). Natural language repositories, expert systems that capture knowledge as well as relay it, empowered cultures, workers more comfortable with sharing information and realizing benefits are all key elements required in a knowledge management system.

The power of core competencies among a workforce is harnessed by creating informal networks of people who do the same or similar kinds of work. These informal networks have been called the "community of practice". Core competencies rely on business information, knowledge and experience that do not fit neatly into a data warehouse. IS managers will have to implement new, flexible technologies that can adapt to different forms of data. Technology will continue to yield disappointing results until IS managers and business executives realize that IT must provide a way to form communities, not simply provide communications (Manville, Foote, 1998).

There are three tools an IS needs in order to harvest workers' knowledge. The first is an information architecture that includes new languages, categories, and metaphors for identifying and accounting for skills and competencies. The second is a technical architecture that is more social such as the Internet. The third is application architecture oriented toward problem solving and representation, rather than output and transactions. The following

applications would address an organization's knowledge management needs. First, eliciting the knowledge of experts is important. Implementing a methodology and tools to capture knowledge of employees requires the implementation of the concept browser to elicit the knowledge of the organization's experts. In addition, there should be an expert seeker application that identifies experts within the organization. Collaborative computing and workflow tools that will enhance the collaboration within and across functional organizations are also important. Such tools enhance decision making by identifying previously encountered scenarios similar to the current ones, adapt the previous experiences to the current problems, and thus provide a new solution. (Becerra-Fernandez, 1998).

A common feature of successful knowledge projects is the use of common language (Skyrme, 1997). Typically the literature points to the use of knowledge databases where common language is gathered. There are several steps that information professionals can take to make to move beyond basic knowledge 'databases' to something more useful. Database formats have the obvious advantages of transmittability, ease of access and speed of dissemination (Skyrme, 1997). Another aspect of technology infrastructure is a common pervasive set of technologies for desktop computing and communications. This basically means a capable, networked PC on every desk or in every briefcase with standardized personal productivity tools such as word processing and presentation software so that people can exchange documents easily. Another technology likely to make it easier for disparate groups with similar needs and interests to access one another's knowledge base is collaborative filtering. Collaborative filtering works by first building a profile of a user's interests, then tracking the information each user requests from servers. Next, the software compares the user's interests with those of others and displays the information one user has accessed to other users with similar interests. Collaborative filtering allows people see whether others found that information useful. While collaborative filtering may prove useful on Intranets, no technology can single-handedly deliver knowledge management (Hibbard, Carillo, 1998).

A learning history can help managers capture institutional experience, spread its lessons, and translate them into effective action. Almost all of such a history, which is a written narrative of a firm's recent critical event, is presented in two contexts. In one, relevant episodes are described by those who participated in them, were influenced by them, or watched them. In the other, trained outsiders and informed insiders identify recurrent motifs in the narrative, ask questions, and raise possible issues. This method, which is based on the ancient practice of community storytelling, can increase trust, raise significant issues, move knowledge from one area of a firm to another or even between public and private entities and help create a body of generalizable knowledge (Kleiner, Roth, 1997).

Conclusions

This paper has been an attempt to address a new approach to capturing and disseminating knowledge to the space workforce of the next century. The general tendency on this subject today to link "knowledge networks" and "knowledge management". Most people will think of sophisticated computer systems. They'll picture product designers sharing ideas through an intranet, plant managers tapping into an on-line database of effective manufacturing practices, or a sales team pulling a proposal together using E-mail. But research suggests that it may be shortsighted to think about knowledge networks only in terms of technology. Often, the most important factor in managing knowledge is the way a company organizes its units and people. Human links, not electronic ones, are the key. (Cliffe, 1998).

The technology of knowledge databases is less important to some than their purpose, sociology, and management. A company that is interested in technical possibilities runs the risk of creating an expensive sinkhole rather than a font of knowledge (Stewart, 1998). Research by Skyrme (1997) has shown how critical it is to have a culture of knowledge sharing. In such a culture, free flowing conversation, open dialogue across organizational boundaries, team and networking building are important mechanisms for creating high levels of innovation and learning. Communities of practice form and share knowledge on the basis of the desire of individual members, not a centralized push of information. Knowledge-based strategies must not focus on collecting and disseminating information but rather on creating a mechanism for practitioners to reach out to other practitioners. The construction of the International Space Station, Future-X vehicles, and other major multinational and multi-organizational endeavors requires such a culture and strategy in the space community. Communities of practice must have the necessary tools to form, evolve, and develop as freely as possible. In addition to user-empowered tools and approaches, communities of practice must be able to identify skills and competencies of other potential members.

According to a recent InformationWeek research survey of 150 IT managers, the primary barrier to implementing knowledge-management solutions is competing organizational priorities. Surely this same result may apply to cooperative efforts between the public and private sectors as well as international efforts. Strong support from executives and government leaders is crucial for transformation-oriented knowledge projects. Such executives send messages that knowledge management and organizational learning are critical to a company or even a country's success. In addition, it is critical to provide funding and other resources for infrastructure, and clarify what types of knowledge are most important to the endeavor. Even where the opportunities for exchange exist, executive support is present and people anticipate that value may be created through exchange or interaction, those involved must feel that their engagement in the knowledge exchange and combination will be worth their while. For example, while having considerable potential, the availability of electronic knowledge exchange does not automatically induce a willingness to share information and build new intellectual capital.

The existing body of work on knowledge management systems consists primarily of general and conceptual principals of knowledge management systems and case descriptions of such systems in a handful of organizations. Because knowledge management systems are just beginning to appear in organizations, there exists little research and insight to guide the successful development and implementation of such systems, or to frame expectations of the benefits and costs of such systems (O'Leary, 1998). Increased realization of knowledge as the core competence, coupled with recent advances in information technology such as Intranets and the World Wide Web, has increased organizational interest in the topic of knowledge management. A variety of strategies, frameworks, and tools have been presented which address the complex issue of knowledge management. Certainly, top management support and a sharing culture are requirements for success. The definitions of knowledge management and knowledge are general yet clear enough for any organization to begin structuring a program that suits its needs. The future of knowledge management is open to speculation due to its ambiguities, conflicting definitions, and inherent difficulties in quantifying results. However, for the space workforce to succeed in such a challenging arena, they must learn new and effective ways of sharing all they know with present and future employees.

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