JOINT ADVANCED STUDENT SCHOOL 2008, ST. PETERSBURG

SOFTWARE DECISION FOR KNOWLEDGE MANAGEMENT

Final Report by

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Submitted: 01.03.2008

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Introduction

Knowledge is the most valuable asset for any organization. A company can be competitive only if its knowledge is conveniently preserved and used in an efficient way. In the last ten years, knowledge management (KM) has developed from something unclear into a substantial body of modern organizations, including the management of intellectual and social capital, the promotion of innovation and support for new forms of collaborative working. Not all information is valuable. Therefore, it's up to individual companies to determine what information qualifies as intellectual and knowledge-based assets.

1. What is Knowledge

Knowledge is the ability to convert data and information in effective actions KM is hard to define precisely and simply [Levinson, 2006].

Knowledge may be accessed at three stages [Wikipedia, 2007]: before, during, or after knowledge-related activities.

For example, individuals undertaking a new project for an organization might access information resources to learn best practices and lessons learned for similar projects undertaken previously, access relevant information again during the project implementation to seek advice on issues encountered, and access relevant information afterwards for advice on after-project actions and review activities. Knowledge management practitioners offer systems, repositories, and corporate processes to encourage and formalize these activities.

Similarly, knowledge may be captured and recorded before the project implementation, for example as the project team learns lessons during the initial project analysis. Similarly, lessons learned during the project operation may be recorded, and after-action reviews may lead to further insights and lessons being recorded for future access.

Different organizations have tried various knowledge capture incentives, including making content submission mandatory and incorporating rewards into performance measurement plans. There is controversy over whether incentives work or not in this field and no firm consensus has emerged.

2. What is Knowledge Management

KM is hard to define precisely and simply. Wikipedia [Wikipedia, 2007] says that KM is a management theory, that seeks to understand the way in which knowledge is created, used and shared within organizations. Much clearer definition is given by Gene Bellinger [Bellinger, 2004] – KM is the capture, retention, and reuse of the foundation for imparting an understanding of how all these pieces fit together and how to convey them meaningfully to some other person.

KM process is circular and unending [Allee, 2005]. Participants in the KM process may enter it at any point, and traverse it repeatedly. Each category often presents decision-making opportunities, passive and active, and the categories help identify a knowledge domain. The categories are:

- Asset utilization,
- Knowledge evaluation,
- Knowledge improvement,
- Knowledge accumulation,
- Knowledge generation,
- Knowledge sharing,
- Knowledge protection.
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2.1. Objective of knowledge management

An objective of mainstream knowledge management is to ensure that the *right* information is delivered to the *right* person just in time, in order to take the most appropriate decision (Figure 1).

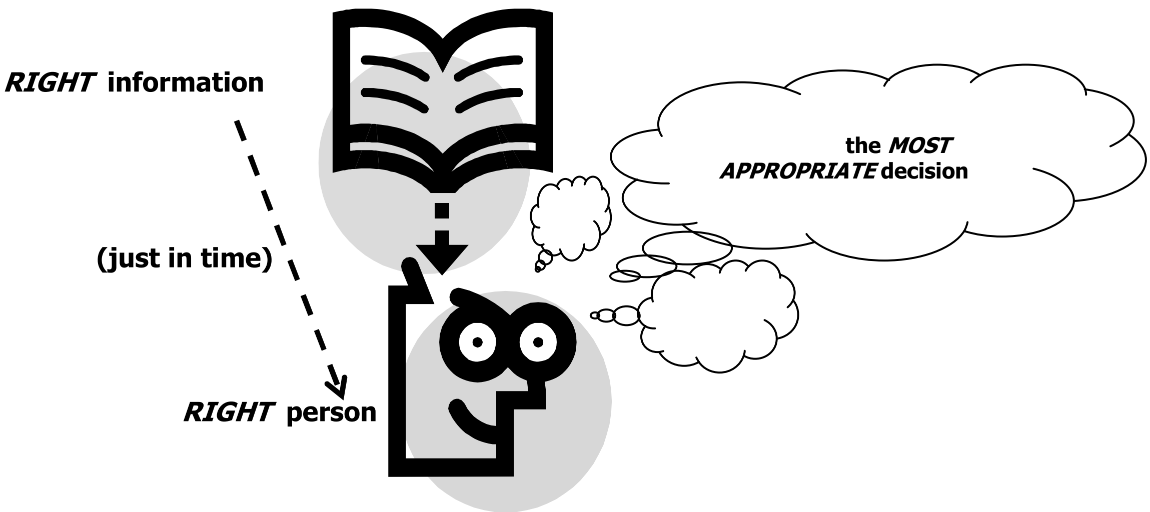

Figure 1 – Objective of KM

In that sense, knowledge management is not interested in managing knowledge, but to relate knowledge and its usage. More recent developments have focused on managing networks (the flow of knowledge rather than knowledge itself) and narrative forms of knowledge exchange.

2.2. Knowledge management: a cross-disciplinary domain

Knowledge management draws from a wide range of disciplines and technologies [Barclay&Murray, 1997] (Figure 2):

- cognitive science,
- expert systems,
- artificial intelligence and knowledge base management systems,
- computer-supported collaborative work (groupware),
- library and information science,
- technical writing,
- document management,
- decision support systems,
- semantic networks,
- relational and object databases,
- simulation,
- organizational science.

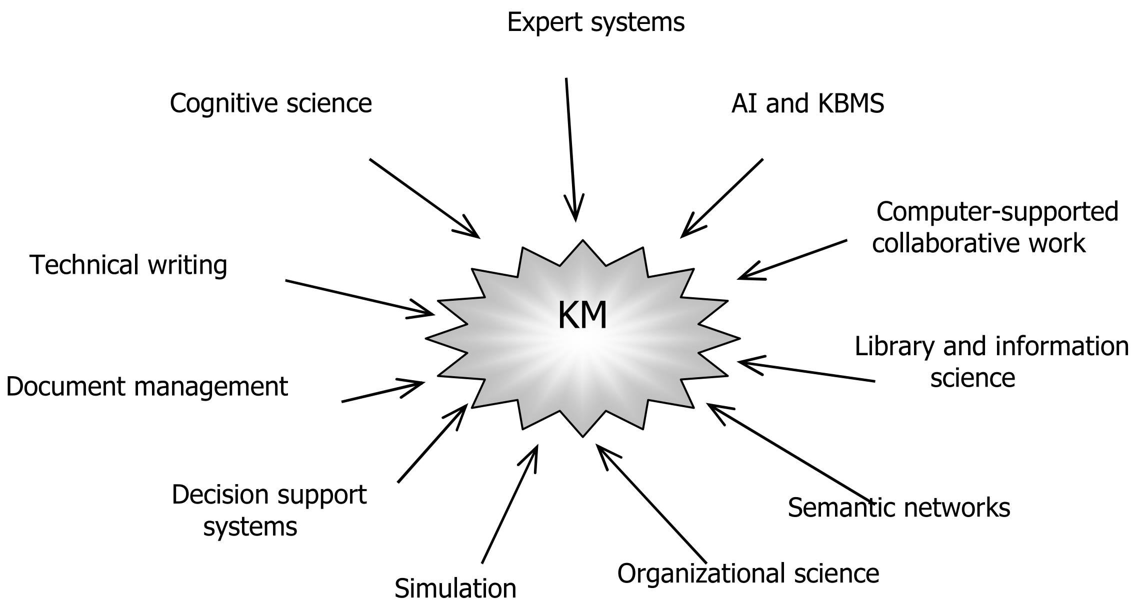

Figure 2 – Technologies Used in KM

That is only the part of the list. There are many other technologies, including object-oriented information modeling, electronic publishing technology, the World Wide Web, and performance support systems.

2.3. Two models of knowledge management theory

A significant part of Knowledge Management theory and practice aligns two models: the DIKW model and Polanyi’s model [Wikipedia, 2007]. The DIKW model places data, information, knowledge and wisdom into an increasingly useful pyramid, where each layer adds certain attributes over and above the previous one (Figure 3). Data is the most basic level. Information adds context. Knowledge adds how to use it, and Wisdom adds when to use it.

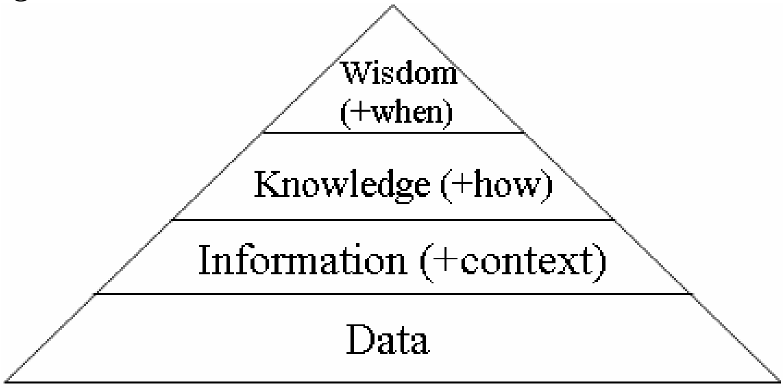

Figure 3 – The DIKW Model

As such, DIKW is a model that can be useful to understanding analysis and the importance and limits of conceptual works. DIKW is meant to apply to the fields of information science and knowledge management.

Data is the basic unit of information, which in turn is the basic unit of knowledge, which itself is the basic unit of wisdom. So, there are four levels in the understanding and decision-making hierarchy. The whole purpose in collecting data, information, and knowledge is to be able to make wise decisions.

The DIKW model assumes the following chain of action:

- Data comes in the form of raw observations and measurements.
- Information is created by analyzing relationships and connections between the data. It is capable of answering simple "who/what/where/when/why" style questions. Information is a message, there is an (implied) audience and a purpose.
- Knowledge is created by using the information for action. Knowledge answers the question "how". Knowledge is a local practice or relationship that works.
- Wisdom is created through use of knowledge, through the communication of knowledge users, and through reflection. Wisdom answers the questions "why" and "when" as they relate to actions. Wisdom deals with the future, as it takes implications and lagged effects into account.

Polanyi's model (Figure 4) reflects distinction between tacit and explicit knowledge.

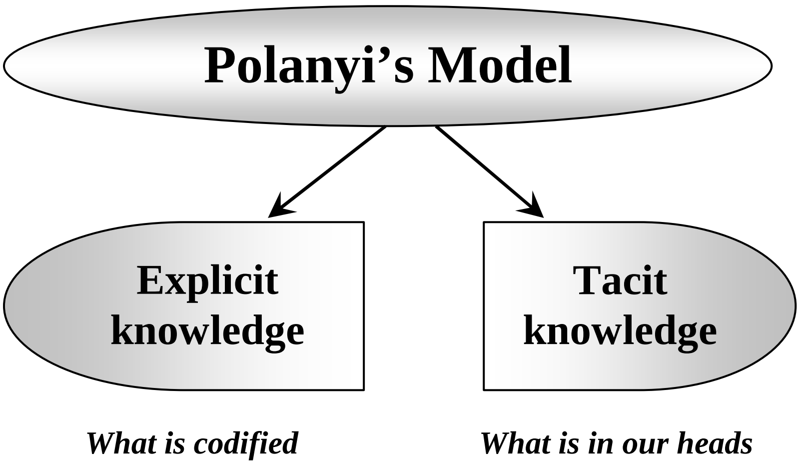

Figure 4 - Polanyi's model

The idea of Polanyi’s model is that the former is often subconscious, internalized, and the individual may or may not be aware of what he or she knows and how he or she accomplishes particular results. At the opposite end of the spectrum is conscious or explicit knowledge – knowledge that the individual holds explicitly and consciously in mental focus, and may communicate to others.

As a general rule of thumb, explicit knowledge consists of anything that can be documented, archived and codified, often with the help of IT.

Much harder to grasp is the concept of tacit knowledge, or the know-how contained in people's heads. The challenge inherent with tacit knowledge is figuring out how to recognize, generate, share and manage it. While IT in the form of e-mail, groupware, instant messaging and related technologies can help facilitate the dissemination of tacit knowledge, identifying tacit knowledge in the first place is a major hurdle for most organizations.

2.4. Why do we need knowledge management

There’re some specific business factors, including:

- Marketplaces are increasingly competitive and the rate of innovation is rising;
- Reductions in staffing create a need to replace informal knowledge with formal methods;
- Competitive pressures reduce the size of the work force that holds valuable business knowledge;.
- The amount of time available to experience and acquire knowledge has diminished;
- Early retirements and increasing mobility of the work force lead to loss of knowledge;
- There is a need to manage increasing complexity as small operating companies are trans-national sourcing operations;
- Changes in strategic direction may result in the loss of knowledge in a specific area;
- Most of our work is information based;
- Organizations compete on the basis of knowledge;
- Products and services are increasingly complex, endowing them with a significant information component.

3. Knowledge Management: Past and Future

3.1. Knowledge management history

KM is a very young theory. A number of management theorists have contributed to the evolution of knowledge management [Woods, 2004]. Among them such notables as Peter Drucker, Paul Strassmann, and Peter Senge in the United States. Drucker and Strassmann have stressed the growing importance of information and explicit knowledge as organizational resources, and Senge has focused on the "learning organization," a cultural dimension of managing knowledge. Chris Argyris, Christoper Bartlett, and Dorothy Leonard-Barton of Harvard Business School have examined various facets of managing knowledge. In fact, Leonard-Barton's well-known case study of Chaparral Steel, a company which has had an effective knowledge management strategy in place since the mid-1970s, inspired the research documented in her *Wellsprings of Knowledge — Building and Sustaining Sources of Innovation* (Harvard Business School Press, 1995).

Everett Rogers' work at Stanford in the diffusion of innovation and Thomas Allen's research at MIT in information and technology transfer, both of which date from the late 1970s, have also contributed to our understanding of how knowledge is produced, used, and diffused within organizations. By the mid-1980s, the importance of knowledge (and its expression in professional competence) as a competitive asset was apparent, even though classical economic theory ignores (the value of) knowledge as an asset and most organizations still lack strategies and methods for managing it.

Recognition of the growing importance of organizational knowledge was accompanied by concern over how to deal with exponential increases in the amount of available knowledge and increasingly complex products and processes. The computer technology that contributed so heavily to superabundance of information started to become part of the solution, in a variety of domains. Doug Engelbart's Augment (for "augmenting human intelligence"), which was introduced in 1978, was an early hypertext/groupware application capable of interfacing with other applications and systems. Rob Acksyn's and Don McCracken's Knowledge Management System (KMS), an open distributed hypermedia tool, is another notable example and one that predates the World Wide Web by a decade.

The 1980s also saw the development of systems for managing knowledge that relied on work done in artificial intelligence and expert systems, giving us such concepts as "knowledge acquisition," "knowledge engineering," "knowledge-base systems, and computer-based ontologies.

The phrase "knowledge management" entered the lexicon in earnest. To provide a technological base for managing knowledge, a consortium of U.S. companies started the Initiative for Managing Knowledge Assets in 1989. Knowledge management-related articles began appearing in journals like *Sloan Management Review*, *Organizational Science*, *Harvard Business Review*, and others, and the first books on organizational learning and knowledge management were published (for example, Senge's *The Fifth Discipline* and Sakaiya's *The Knowledge Value Revolution*).

By 1990, a number of management consulting firms had begun in-house knowledge management programs, and several well known U.S., European, and Japanese firms had instituted focused knowledge management programs. Knowledge management was introduced in the popular press in 1991, when Tom Stewart published "Brainpower" in *Fortune* magazine. Perhaps the most widely read work to date is Ikujiro Nonaka's and Hirotaka Takeuchi's *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation* (1995).

By the mid-1990s, knowledge management initiatives were flourishing, thanks in part to the Internet. The International Knowledge Management Network (IKMN), begun in Europe in 1989, went online in 1994 and was soon joined by the U.S.-based Knowledge Management Forum and other KM-related groups and publications. The number of knowledge management conferences and seminars is growing as organizations focus on managing and leveraging explicit and tacit knowledge resources to achieve competitive advantage. In 1994 the IKMN published the results of a knowledge management survey conducted among European firms, and the European Community began offering funding for KM-related projects through the ESPRIT program in 1995.

Brief KM history is presented in Figure 5.

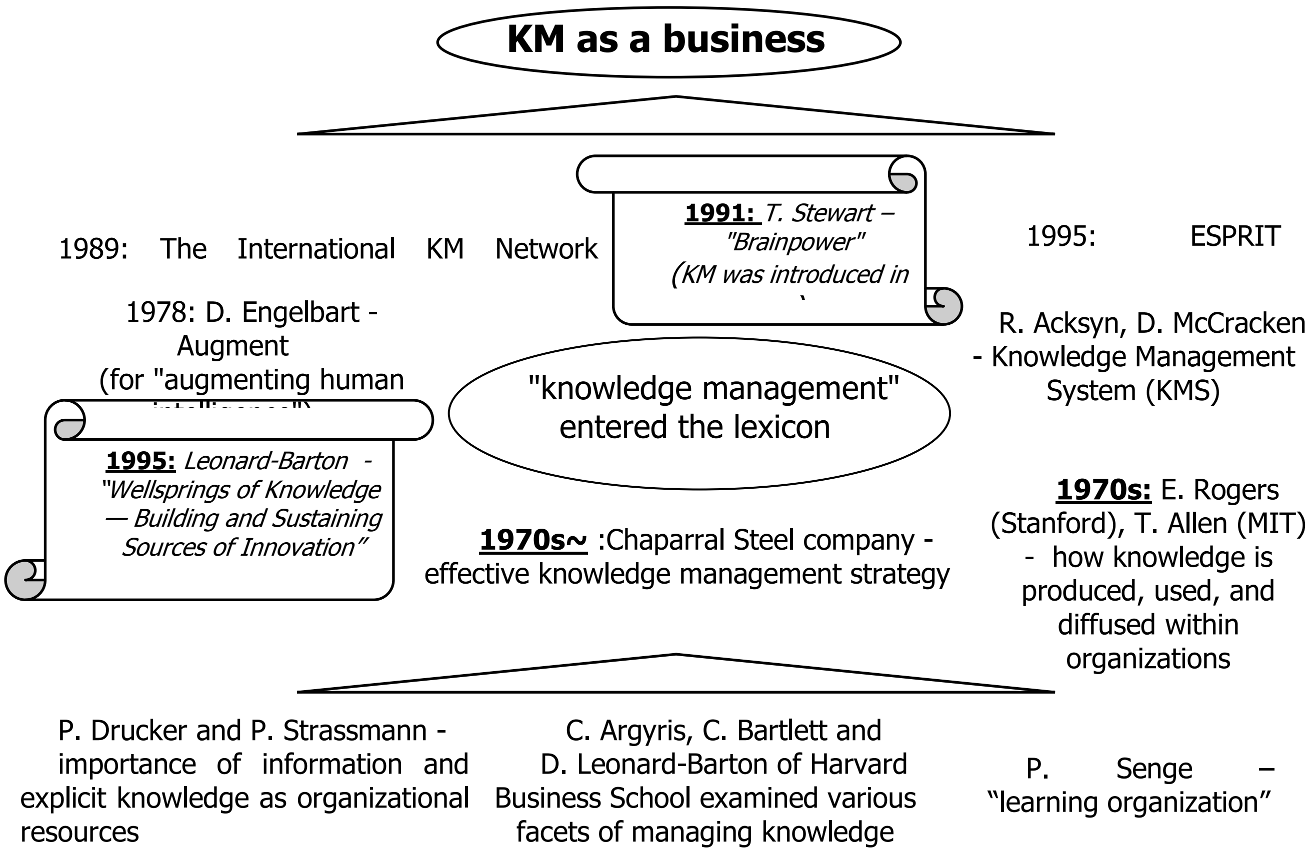

Figure 5 – History of KM

3.2. State-of-the-art

KM system refers to a (generally IT based) system for managing knowledge in organizations, supporting creation, capture, storage and dissemination of information. The idea of a KM system is to enable employees to have ready access to the organization's based documented of facts, sources of information, and solutions. For example a typical claim justifying the creation of a KM system might run something like this: an engineer could know the metallurgical composition of an alloy that reduces sound in gear systems. Sharing this information organization wide can lead to more effective engine design and it could also lead to ideas for new or improved equipment.

A KM system could be any of the following:

– Document based i.e. any technology that permits creation/management/sharing of formatted documents such as Lotus Notes, web, distributed databases etc.

– Ontology/Taxonomy based: these are similar to document technologies in the sense that a system of terminologies (i.e. ontology) are used to summarize the document e.g. Author, Subj, Organization etc. as in DAML & other XML based ontologies

– Based on AI technologies which use a customized representation scheme to represent the problem domain.

– Provide network maps of the organisation showing the flow of communication between entities and individuals

– Increasingly social computing tools are being deployed to provide a more organic approach to creation of a KM system.

Some of the advantages claimed for KM systems are:

– Sharing of valuable organizational information.
– Can avoid re-inventing the wheel, reducing redundant work.
– May reduce training time for new employees
– Retention of Intellectual Property after the employee leaves if such knowledge can be codified.

Technologies that use KM are presented in Figure 6.

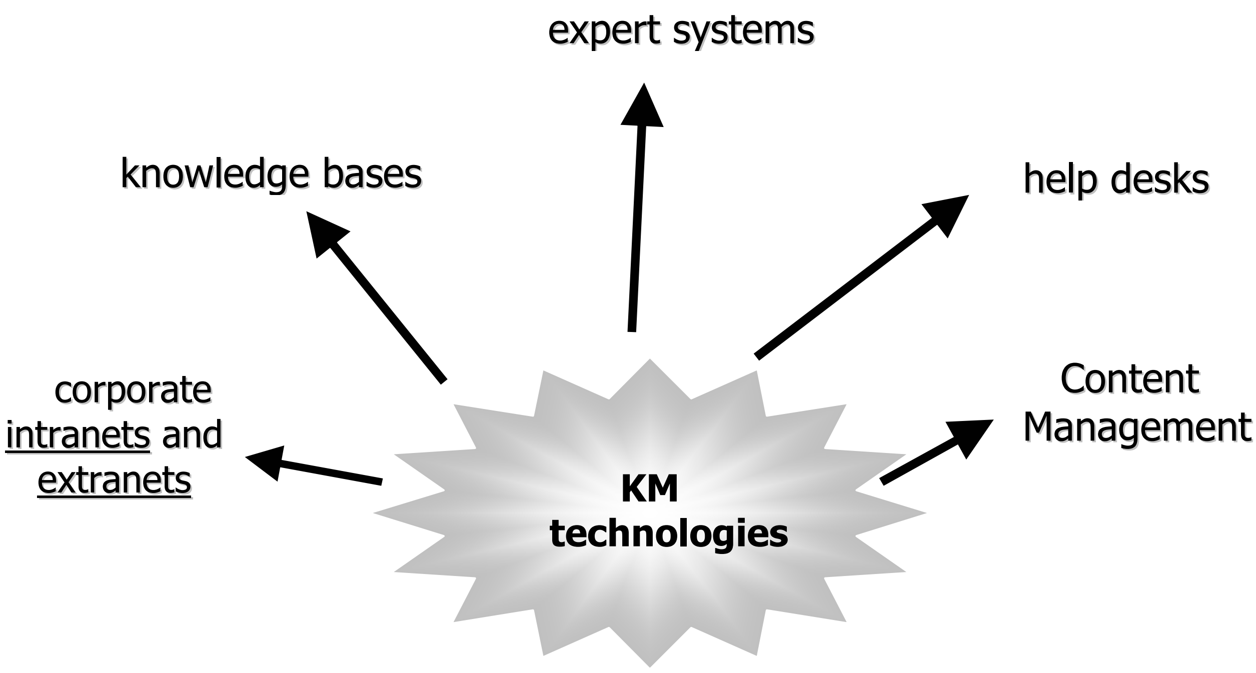

Figure 6 – KM technologies

A *knowledge base* is a special kind of database for knowledge management. It provides the means for the computerized collection, organization, and retrieval of knowledge. Knowledge bases can be machine- or human-readable. Machine-readable knowledge bases store knowledge in a computer-readable form. Human-readable knowledge bases are designed to allow people to retrieve and use the knowledge they contain, primarily for training purposes.

An *expert system*, also known as a knowledge based system, is a computer program that contains some of the subject-specific knowledge, and contains the knowledge and analytical skills of one or more human experts (Examples of expert systems: Dendral, Mycin, Prolog, Dipmeter Advisor).

A *help desk* is an information and assistance resource that troubleshoots problems with computers and similar products. Corporations often provide help desk support to their customers via a toll-free number, website and/or e-mail. There are also in-house help desks geared toward providing the same kind of help for employees only. Some schools offer classes in which they perform similar tasks as a help desk.

Content management is a set of processes and technologies that support the evolutionary life cycle of digital information. This digital information is often referred to as content or, to be precise, digital content. Digital content may take the form of text, such as documents, multimedia files, such as audio or video files, or any other file type which follows a content lifecycle which requires management.

Some benefits of KM correlate directly to bottom-line savings, while others are more difficult to quantify. In today's information-driven economy, companies uncover the most opportunities — and ultimately derive the most value — from intellectual rather than physical assets. To get the most value from a company's intellectual assets, KM practitioners maintain that knowledge must be shared and serve as the foundation for collaboration. Yet better collaboration is not an end in itself; without an overarching business context, KM is meaningless at best and harmful at worst. Consequently, an effective KM program should help a company do one or more of the following:

- Sharing of valuable organizational information;
- Can avoid re-inventing the wheel, reducing redundant work;
- May reduce training time for new employees;
- Retention of Intellectual Property after the employee leaves if such knowledge can be codified.

4. Ontology Engineering

4.1What is An Ontology?

The Artificial-Intelligence literature contains many definitions of an ontology; many of these contradict one another. For the purposes of this guide an ontology is a formal explicit description of concepts in a domain of discourse (**classes** (sometimes called **concepts**)), properties of each concept describing various features and attributes of the concept (**slots** (sometimes called **roles** or **properties**)), and restrictions on slots (**facets** (sometimes called **role restrictions**)). An ontology together with a set of individual **instances** of classes constitutes a **knowledge base**. In reality, there is a fine line where the ontology ends and the knowledge base begins. Classes are the focus of most ontologies. Classes describe concepts in the domain. For example, a class of wines represents all wines. Specific wines are instances of this class. The *Bordeaux* wine in the glass in front of you while you read this document is an instance of the class of *Bordeaux* wines. A class can have **subclasses** that represent concepts that are more specific than the superclass. For example, we can divide the class of all wines into red, white, and rosé wines. Alternatively, we can divide a class of all wines into sparkling and non-sparkling wines.

Slots describe properties of classes and instances: *Château Lafite Rothschild Pauillac* wine has a full body; it is produced by the *Château Lafite Rothschild* winery. We have two slots describing the wine in this example: the slot body with the value full and the slot maker with the value *Château Lafite Rothschild* winery. At the class level, we can say that instances of the class Wine will have slots describing their flavor, body, sugar level, the maker of the wine and so on. All instances of the class Wine, and its subclass *Pauillac*, have a slot maker the value of which is an instance of the class Winery. All instances of the class Winery have a slot produces that refers to all the wines (instances of the class Wine and its subclasses) that the winery produces.

4.2 Why We Need An Ontology?

The basic philosophical definition and its further development are pointing that term ontology stands for study of “being” [9]. But in information science now ontology is a set of distinctions, explicitly made in order to understand and view the world. There is well-known definitions of this milestone term [4]: *Ontology defines the basic terms and relations comprising the structured vocabulary of a topic area, as well as the rules for combining terms and relations to define extensions to the vocabulary*.

An ontology defines a common vocabulary for researchers who need to share information in a domain. It includes machine-interpretable definitions of basic concepts in the domain and relations among them.

Why would someone want to develop an ontology? Some of the reasons are:

Sharing common understanding of the structure of information among people or software agents is one of the more common goals in developing ontologies [7]. For example, suppose several different Web sites contain medical information or provide medical ecommerce services. If these Web sites share and publish the same underlying ontology of the terms they all use, then computer agents can extract and aggregate information from these different sites. The agents can use this aggregated information to answer user queries or as input data to other applications.

Enabling reuse of domain knowledge was one of the driving forces behind recent surge in ontology research. For example, models for many different domains need to represent the notion of time. This representation includes the notions of time intervals, points in time, relative measures of time, and so on. If one group of researchers develops such an ontology in detail, others can simply reuse it for their domains. Additionally, if we need to build a large ontology, we can integrate several existing ontologies describing portions of the large domain.

Making explicit domain assumptions underlying an implementation makes it possible to change these assumptions easily if our knowledge about the domain changes. A Hard-coding assumption about the world in programming-language code makes these assumptions not only hard to find and understand but also hard to change, in particular for someone without programming expertise. In addition, explicit specifications of domain knowledge are useful for new users who must learn what terms in the domain mean.

Separating the domain knowledge from the operational knowledge is another common use of ontologies. We can describe a task of configuring a product from its components according to a required specification and implement a program that does this configuration independent of the products and components themselves [6]. We can then develop an ontology of PC-components and characteristics and apply the algorithm to configure made-toorder PCs. We can also use the same algorithm to configure elevators if we "feed" an elevator component ontology to it [8].

Analyzing domain knowledge is possible once a declarative specification of the terms is available. Formal analysis of terms is extremely valuable when both attempting to reuse existing ontologies and extending them [5]. Developing an ontology is akin to defining a set of data and their structure for other programs to use. Problem-solving methods, domain-independent applications, and software agents use ontologies and knowledge bases built from ontologies as data.

This definition clarifies the ontological approach to knowledge structuring while providing sufficient freedom for open-ended, creative thinking. For example, ontological engineering can provide a clear representation of a company's structure, human resources, physical assets, and products, and their inter-relationships. Ontology as a useful structuring tool may greatly enrich modeling process, providing users of KM-systems an organizing axis to help them mentally mark their vision of the domain knowledge.

4.3 The Survey of Development of Ontology Engineering and Applications

In recent years the development of ontologies—explicit formal specifications of the terms in the domain and relations among them—has been moving from the realm of Artificial- Intelligence laboratories to the desktops of domain experts. Ontologies have become common on the World-Wide Web. The ontologies on the Web range from large taxonomies categorizing Web sites (such as on Yahoo!) to categorizations of products for sale (such as on eBay.com). The WWW Consortium (W3C) is developing the Resource Description Framework [1], a language for encoding knowledge on Web pages to make it understandable to electronic agents searching for information. The Defense Advanced Research Projects Agency (DARPA), in conjunction with the W3C, is dc efforts to develop the UNSPSC ontology which provides terminology for products and services (www.unspsc.org)

4.4 How to Build An Ontology?

In practical terms, developing an ontology includes:

·defining classes in the ontology,

·arranging the classes in a taxonomic (subclass–superclass) hierarchy,

·defining slots and describing allowed values for these slots,

·filling in the values for slots for instances.

Generally, there is a *Four-step Algorithm* to create ontology [2]:

Step1. Goals, strategy and boundary identification: identifying the purpose of the ontology, frame work of the system and the needs for the *domain knowledge acquisition*.

Step2. Glossary development or meta-concept identification: This time consuming step is devoted to gathering all the information relevant to the described domain after the data analyzing and summarizing.

Step3. Laddering and estimating, including categorization and specification: Defining the main levels of abstraction, create the relationship and properties of each node, ensure the veracity and integrity of architecture of solving process.

Step4. Refinement: Updating the visual structure by excluding any excessiveness, synonymy, and contradictions. The main goal of the final step is try to create a refined ontology.

Harmony: To achieve harmony, we attempt to follow some principles to achieve the goal:

·**Conceptual balance:** A well-balanced ontological hierarchy equates to a strong and comprehensible representation of the domain's knowledge. Ill-balanced ontology design shows that long branches are over-detailed, while shorter ones are under-investigated.

·**Clarity:** In addition to the principle of harmony, it is important to pay attention to clarity when building a comprehensible ontology. Clarity may be provided through a number of concepts, and types of the relationships among the concepts.

5. Ontology-based Knowledge Portal

5.1 Why We Develop An Ontology-based Knowledge Portal?

Today, knowledge portals make an important contribution to enabling enterprise knowledge management by providing users with a consolidated, personalized user interface that allows e-client access to various types of (structured and unstructured) information. Various technologies are used to designing and implementing to achieve this goal. Traditionally, we use content-based approach to construct the web portal, which allows combining different portal components side by side in a single portal webpage.

However, like other information system existing today, a major challenge of it is to provide right information at right time. Navigation through mass of information represented on the web is still not expedient and effective, as well as the development and maintenance. People always waste plenty of time for searching exact information or knowledge they want. The same situation is to the designer, who is weighed down with construction of architecture of web pages in different areas or domain that have not any distinct relationship or logical links.

The emerging *ontology-based approach*, which serves as a semantic backbone for knowledge modeling, accessing and representing can be used to filling up these short comings and desire [3]. As its one of application branches, the ontology-based web service, which is considered to be next generation web technology or web 3.0 by W3C, has been exploited and put into practice in recent ten years. For KPs, ontology can be regarded as the classification of knowledge, that is to say, ontology defines shared vocabulary for facilitating knowledge communication, storing, searching and sharing in knowledge management systems, which helps people to find their exactly answers through the navigation of the internet or database, and simplify the construction of data warehouse by only change the value or property of the object.

5.2 Logical Architecture

In this architecture (see Fig1), a knowledge worker interacts with a knowledge portal to access the content of the KP, which is maintained in a document base and organized using ontologies in information spaces. The interaction is recorded in a usage log. This usage information and the information about changes in the document base are exploited to recommend changes to the ontologies, thus closing the loop with the knowledge engineer.

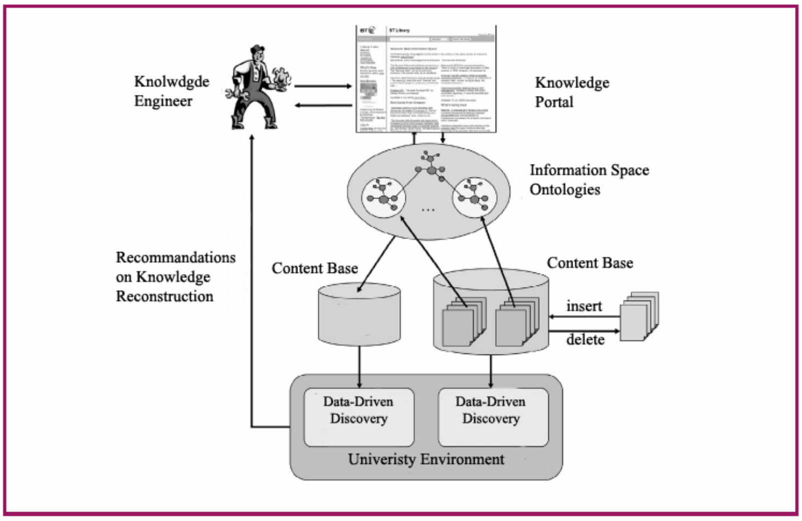

Figure 1. Logical architecture

5.3 Practical Architecture

In practical architecture, the KP mainly distinguishes three layers (see Fig2):

1. Information Access Layer. It is an interface to the users, which can perform the interaction and assessment with the end-users.
2. Information Processing Layer. Based on the evaluation of the grounding technologies layer, this section exposes the evaluation criteria required for a functional analysis of the information processing features of a semantic web portal.
3. Grounding Technologies Layer. System technology is implemented for evaluation for semantic KP by using data management and system maintenance technology [4]. By using ontologies, which is central component used to structure and formalize the information into knowledge, semantic web technology is utilized to publish ontologies onto the web.

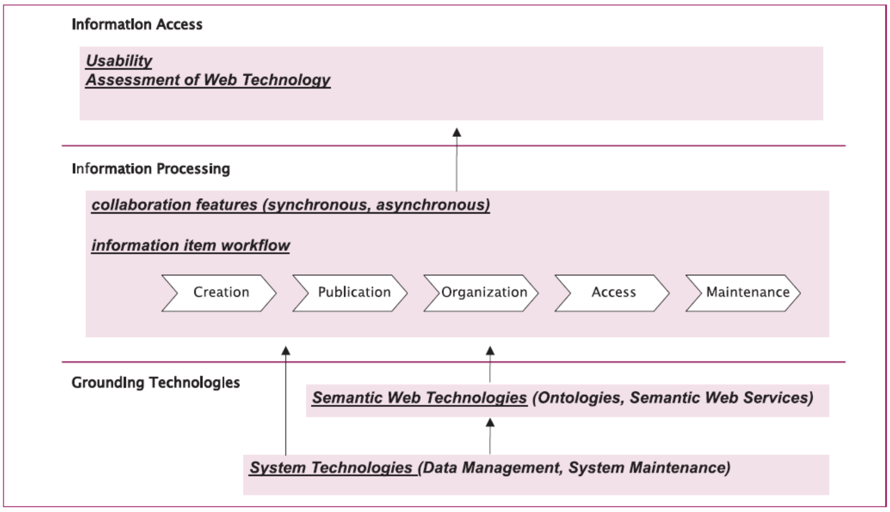

Figure 2. Practical Architecture

Perspectives

Technology will clearly become more helpful in dealing with information overload. The current capability of machine intelligence is such that, for the great majority of business applications, human knowledge will continue to be a valuable resource for the foreseeable future, and technology to help to leverage it will be increasingly valuable and capable.

The major problems that occur in KM usually result because companies ignore the people and cultural issues. In an environment where an individual's knowledge is valued and rewarded, establishing a culture that recognizes tacit knowledge and encourages employees to share it is critical. The need to sell the KM concept to employees shouldn't be underestimated; after all, in many cases employees are being asked to surrender their knowledge and experience — the very traits that make them valuable as individuals.

Conclusion

KM is rooted in many disciplines including business, economics, education, information management, psychology, and sociology among others. These areas have developed perspectives on the workings of individual and systemic knowledge. Not all information is valuable. Therefore, it's up to individual companies to determine what information qualifies as intellectual and knowledge-based assets.

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