A New Framework for a Technological Perspective of Knowledge Management

by

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Thesis submitted in fulfilment of the requirements for the degree
Doctor of Philosophy in Computer Science

In the Faculty of Engineering, Built Environment
and Information Technology

Department of Computer Science

University of Pretoria
Pretoria

January 2006

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Dedicated to

My wife of 32 years Katrien;
My children Cor, Alet, and Kobie; and
My mother.

Acknowledgements

The Almighty, who granted us the desire and capability to learn about His unbelievable creation.

My supervisor, Professor Derrick Kourie, who made such valuable remarks and suggestions (and taught me a number of new words in English, my second language).

My family, extended family, friends, and colleagues in a number of different career situations who inspired me and kept on believing in the result.

My associates in my new endeavours, especially in Network21, who helped me to keep on dreaming, to reach for bigger goals, and to never give up.

Abstract

Rapid change is a defining characteristic of our modern society. This has huge impact on society, governments, and businesses. Businesses are forced to fundamentally transform themselves to survive in a challenging economy. Transformation implies change in the way business is conducted, in the way people perform their contribution to the organisation, and in the way the organisation perceives and manages its vital assets – which increasingly are built around the key assets of intellectual capital and knowledge.

The latest management tool and realisation of how to respond to the challenges of the economy in the new millennium, is the idea of "knowledge management" (KM). In this study we have focused on synthesising the many confusing points of view about the subject area, such as:

a. different focus points or perspectives;

b. different definitions and positioning of the subject; as well as

c. a bewildering number of definitions of what knowledge is and what KM entails.

There exists a too blurred distinction in popular-magazine-like sources about this area between subjects and concepts such as: knowledge versus information versus data; the difference between information management and knowledge management; tools available to tackle the issues in this field of study and practice; and the role technology plays versus the huge hype from some journalists and within the vendor community. Today there appears to be a lack of a coherent set of frameworks to abstract, comprehend, and explain this subject area; let alone to build successful systems and technologies with which to apply KM.

The study is comprised of two major parts:

1. In the first part the study investigates the concepts, elements, drivers, and challenges related to KM. A set of models for comprehending these issues and notions is contributed as we considered intellectual capital, organizational learning, communities of practice, and best practices.
2. The second part focuses on the technology perspective of KM. Although KM is primarily concerned with non-technical issues this study concentrates on the technical issues and challenges. A new technology framework for KM is proposed to position and relate the different KM technologies as well as the two key applications of KM, namely knowledge portals and knowledge discovery (including text mining).

It is concluded that KM and related concepts and notions need to be understood firmly as well as effectively positioned and employed to support the modern business organisation in its quest to survive and grow. The main thesis is that KM technology is a necessary but insufficient prerequisite and a key enabler for successful KM in a rapidly changing business environment.

Keywords

knowledge, tacit knowledge, explicit knowledge, knowledge management, knowledge conversion life cycle, rapid change, organizational change, organizational learning, intellectual capital, collaboration, advanced search, externalization, internalization, socialization, knowledge sharing, knowledge creation, knowledge representation, taxonomy, ontology, e-learning, knowledge portals, knowledge discovery, text mining, semantic KM aspects, the Semantic Web, communities of practice

Preface

An investment in knowledge pays the best interest. – Benjamin Franklin

***Research should be fun rather than a grind and one should believe in its relevance and value.* –** Peter G.W. Keen (1980)[1]

Remember: research is just re-search! – Dr. Strydom (U.P.)

It is just a Ph.D.! – Prof. Kourie

Rapid discontinuous change

Rapid change is a defining characteristic of the 21st century. This has huge impact on society, governments, and businesses. Businesses are forced to fundamentally transform themselves to survive in a challenging economy. Transformation implies change in the way business is conducted, in the way people perform their contribution to the organisation, and in the way the organisation perceives and manages its vital assets – which increasingly are built around the key assets of intellectual capital and knowledge.

We explain the impact of this in this study and remark on the necessity of a mind shift in many aspects of the modern organization. This need to shift to new business approaches and responses is illustrated in Figure 1. Businesses are obliged to fundamentally change their viewpoints of how to react to the business challenges and how to respond appropriately to be successful.

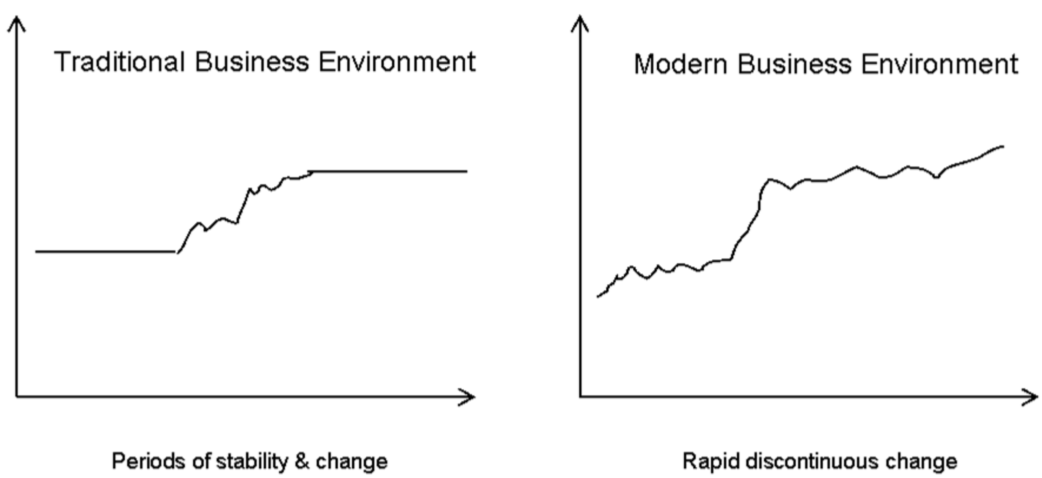

Figure 1: Rapid change requires new business responses

[1] MIS Research: Reference Disciplines and a Cumulative Tradition. Proceedings of the First International Conference on Information Systems, Philadelphia, PA, December 1980

The latest management tool and realisation of how to respond to the challenges of the economy in the new millennium, is the idea of "knowledge management". Knowledge management (KM) became a critical topic for the success of the modern organisation.

There are a number of frameworks and models for comprehending this concept. When first encountered, these representations of the concept of KM are quite confusing. One may say that: "KM is in the mind of the beholder". We adapt and make use of some of these models and frameworks to describe the notion of KM. In doing so, we contribute to the comprehension of the nature of KM.

Although KM is primarily concerned with non-technical issues, this study concentrates on the technical issues and challenges. We propose a set of models and a new technological framework for KM which can be utilised to position and relate the KM technologies, enablers, and applications.

Positioning Knowledge Management as a Field of Study

During this study we focused on knowledge management in business organizations and only hinted at the existence of knowledge management in other spheres of modern society. We illustrate here the broader picture – shown in Figure 2[2]. The different categories are:

- KM of Science – the oldest; about the production of scientific knowledge
- KM of Society – knowledge processes in societies and cultures
- KM in organizations (our main focus) – the youngest; can be categorised as is illustrated in Figure 2, namely:
    - KM in Government
    - KM in Non-profit Organizations
    - KM in Educational Institutions
    - KM in Business. This is the most active and is concerned with improving response to business challenges and profitability. This application of KM is particularly interested in the following:
        - Financial value of knowledge
        - Increasing innovation
        - How to improve profitability and competitiveness by improving knowledge processes
        - Develop an economic model based on knowledge as a resource
        - Many disciplines provide research, instruments, and artefacts including the following:
        - Management science, Information science, organizational science, HR resource development, finance, economics, and information technology.

[2] Adapted from text of eKnowledgeCenter.com

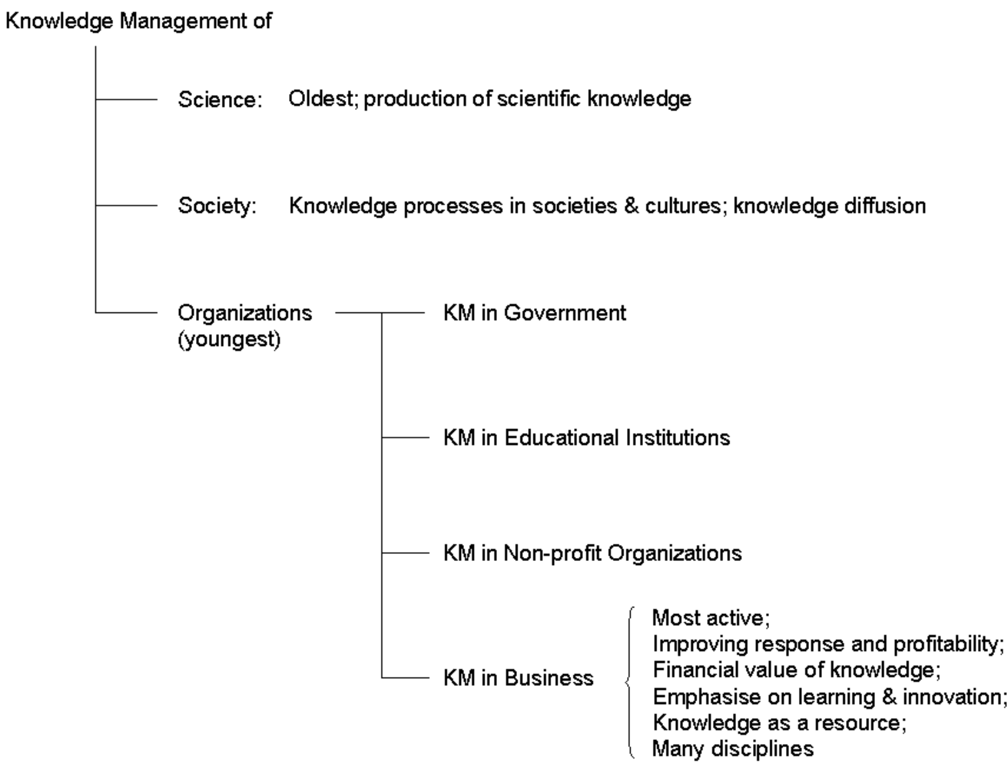

Figure 2: Taxonomy of Knowledge Management

"***Knowledge management is a truly interdisciplinary field. It has developed as a collaborative science involving researchers and practitioners from more than 100 diverse disciplines. Those practitioners realized that they were trying to answer similar questions about the management of knowledge and knowledge processes in organizations, sciences, and society. Although KM has been studied in science for many years, the formation of the field of KM is recent. As a result of the recent interest on the part of the business community in understanding and better managing its knowledge, a supporting industry has been created, with a need for a supporting science. KM has attracted a wide range of disciplines from business management to social sciences and computer science, making it one of the most complex fields ever.***

KM is both a science and an applied science. On the one hand, it asks questions about how individuals and collectives naturally work with knowledge processes such as the production, acquisition, transmission, and use of knowledge. On the other hand, KM applies these studies to improve knowledge processes and their products. As a science, KM seeks to understand how humans naturally manage knowledge processes. As an applied science, it seeks to develop management techniques and tools for improving knowledge processes."[3]

[3] Source: eKnowledgeCenter.com

Reasons for this study

The reasons why this study was undertaken include the following:

- The present renewed interest in this area.
- There is a logical evolution taking place as office systems evolved to groupware/group processing systems and now into knowledge management. The author is fortunate to possess an academic and practitioner background with the first two areas of study
- Confusing points of view about the subject area exist, such as:
    - different focus points;
    - different definitions and positioning of the subject and of various base line issues and areas; as well as
    - a bewildering number of definitions of what knowledge is and what entails KM.
- There exists a too blurred distinction in popular-magazine-like sources about this area between subjects such as:
    - difference between information management and KM;
    - technologies and tools available to tackle the issues in this field of study and practice; and
    - The role technology plays versus the huge hype from certain journalists and within the vendor community.
- A lack of a coherent (alternatively an abundance of (conflicting)) set of frameworks to abstract, comprehend, and explain this subject area; let alone building successful systems to apply KM with and to.
- Many practical issues need to be inspected and more readily clarified; such as best practices for a number of KM issues and applicable technology; versus the new realisation that the well-known best practices of yesteryear may be inapplicable in today's rapid changing environment.
- The interest in the new area of ***knowledge portals*** and ***knowledge discovery (including text mining)*** as the two most promising future applications of and growth points in the technical KM field.

It therefore became important to better comprehend notions such as "***knowledge***" and the management of the processes that involve knowledge. This is what this study aimed at as well as to compile a set of models to better comprehend and synthesize the many viewpoints and approaches that evolved over the last decade. Our contribution is a new technology framework for knowledge management.

Structure of this study

This thesis is structured into two major parts. In Part 1 we consider the background in terms of the "What-is" and "Why" of the challenges that the modern organization has to content with. We notice the rapid and discontinuous change that businesses face and how organizations lately are responding to these challenges and opportunities by embracing knowledge management.

Part 2 builds on Part 1. In Part 2 we consider the "How" and "With-what" of KM. Throughout the study our thesis remains that KM technology is a necessary but not sufficient prerequisite – an enabler – of KM in a rapidly changing environment.

Part 1 – "What is" and "Why"
Part 2 – "How" and "With what"

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Part 1: A Perspective of Knowledge and Knowledge Management Concepts

I think therefore I am. (Cogito, ergo sum) – René Descartes

The power of thinking, is knowing what NOT to think about. – Anonymous

We have modified our environment so radically that we must modify ourselves in order to exist in this new environment. – Norbert Wiener

The rate and magnitude of change are rapidly outpacing the complex of theories – economic, social, and philosophical – on which public and private decisions are based. To the extent that we continue to view the world from the perspective of an earlier, vanishing age, we will continue to misunderstand the developments surrounding the transition to an information society, be unable to realize the full economic and social potential of this revolutionary technology, and risk making some very serious mistakes as reality and the theories we use to interpret it continue to diverge.
– Cordell (1987) as quoted in Malhotra (1993)

About Part 1

This part of the study provides answers to the “what-is” and “why-is” questions in regard to knowledge management. It investigates the concepts and elements, drivers, and challenges involved in knowledge management. After an introductory chapter, a chapter on knowledge in general lays the foundation for an explanatory chapter on knowledge management in particular.

Chapter 4 differentiates the idea of intellectual capital from knowledge management; while chapter 5 shows how the promotion of organizational learning leads to the knowledge-enabled organization.

Chapter 6 emphasizes that knowledge management mostly takes place relative to communities of practice; while chapter 7 identifies best practices in the knowledge management context.

All this information and perspectives provides the background to principle conclusions that are drawn in chapter 8, some of which point to coverage in Part 2.

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Chapter 1 Introduction

For the things we have to learn before we can do them, we learn by doing them.
– Aristotle, Ethics

What we learn and what we remember determine largely who we are.

Memory, not merely facial and physical appearance, defines an individual.

– "***Building a Brainier Mouse***", J. Z. Tsien, Scientific American (April 2000)

For the first time in the history of mankind, we are close to having the biological understanding, the economic ability and the cultural willpower to change the intelligence of future generations. But we do not yet understand what intelligence is.
– As quoted in (Aczel,2000)

When the pace of change outside an organization becomes greater than the pace of change inside the organization, the end is near. – J. R. Walter, President of AT&T

This chapter introduces the idea of knowledge management in section 1.1 by pointing to the context in which the knowledge management idea has emerged, namely a rapidly changing global business environment. Section 1.2 draws attention to the fact that although the idea of knowledge management is well established, there is nevertheless a large degree of confusion about the scope and meaning of the term. This leads to section 1.3 which provides a statement of the goals of the present study, as well as an outline of the structure of this thesis.

1.1 Rapid and Constant Change: The New Challenging Business Environment

We live in an era of rapid change in many facets of our post-2000 society. Tapscott (1996) articulates this well in his much referenced book "***The Digital Economy***" as can be seen in the following selected extracts:

> "***Today we are witnessing the early, turbulent days of a revolution as significant as any other in human history. A new medium of human communications is emerging, one that may prove to surpass all previous revolutions - the printing press, the telephone, the television - in its impact on our economic and social life. The computer is expanding from a tool for information management to a tool for communication ... enabling a new economy based on the networking of human intelligence."***
>
> ***"The Age of Networked Intelligence is an age of promise. It is not simply about the networking of technology but about the networking of humans through technology."***

"But the Age of Networked Intelligence is also an age of potential peril. For individuals, organizations, and societies that fall behind, punishment is swift."

"This is an age of networking not only of technology but of humans, organizations, and societies."

Davis and Meyer (1998) published a thorough coverage of this rapid change and its resulting implications and effects, and appropriately named their book "***Blur; the speed of change in the connected economy***".

In his 1981 book: "***The Third Wave***" Alvin Toffler posited the following three waves in terms of which the world has seen the creation of wealth:

First Wave – the agricultural era; wealth creation was and still is tightly attached to land;

Second Wave – the industrial era; wealth creation happens through industrial production; including mass production, mass consumption, mass education, mass media all linked together and served by specialized institutions; and

Third Wave – the information era; wealth creation is tightly linked to information and knowledge handling.

Some fourteen years later, Alvin and Heidi Toffler (1995) expanded on Alvin's earlier work: "***The Third Wave***" in another influential book: "***Creating a New Civilization; The politics of the Third Wave***". They state for example:

> "***That term 'civilization' ... includes such varied matters as technology, family life, religion, culture, politics, business, hierarchy, leadership, values, sexual morality and epistemology. Swift and radical changes are occurring in every one of these dimensions of society. Change so many social, technology and cultural elements at once and you create not just a transition but a transformation, not just society but the beginnings, at least, of a totally new civilization***."

Newt Gingrich (in his foreword to this book) incisively comments as follows:

> "***The Tofflers correctly understand that development and distribution of information has now become the central productivity and power activity of the human race … on virtually every front we see the information revolution changing the fabric, pace and substance of our lives***."

Although very interesting to take note of, we will not dwell into the implications of this new era for whole societies and governments, but restrict ourselves to the prominent implications this new era imposes on the existence and survival of modern day companies and institutions from our perspective of this study.[1]

[1] A vast literature evolved that cover this very interesting subject. See for example other references such as: Toffler (1981, 1991); Sunter (1992); Davis & Botkin (1995); Sunter (1996); and Grulke(2000).

In an interview conducted by the publication Business Management Asia about his article titled: "***Is knowledge the ultimate competitive advantage?***" Malhotra (2003) was asked why he had argued that sometimes, merely possessing knowledge is not enough, but that application was everything. Malhotra replied:

> "***The key ideas that influence the current global business scenario can be summed up simply in one phrase: radical discontinuous change. Ideas such as change management, learning and unlearning, adaptation, agility and flexibility have been popular over the past few years. However, in the post-1990s era, the rapidity and radical nature of change has assumed unprecedented proportions that defy the past logic based on pre-determination and pre-definition. This has put a premium on thinking beyond benchmarking and best practices, and developing innovative business models that self-obsolete marginal value propositions and processes before competition does so.***
>
> ***From a business strategic perspective, knowledge management is about obsolescing what you know before others do, and profiting by creating the challenges and opportunities others haven't even thought about. In the bigger picture, the focus of knowledge management is on the ever-changing environment in which societies, organisations and individuals live, work, learn, adapt and survive***."

Previously Malhotra (1993) argued that the survival and growth of organizations in an increasingly turbulent environment would depend upon effective utilisation of information technology for aligning the organizational structure with environmental preferences and for creating symbiotic inter-organizational structures.

This trend of constant change necessitates that businesses have to fundamentally transform themselves in order to survive and prosper in a challenging new economy. Transformation implies change in the way business is conducted, in the way people perform their contribution to the organisation, and in the way the organisation perceives and manages its vital assets – which increasingly are built around the key assets of intellectual capital and knowledge.

Over a number of decades organisations have employed various techniques and management tools to manage and adapt to the required change. In the 1980s, the main management tool for changing organisations was to focus on quality. "Total Quality" and "Continuous Improvement" were management tools seen as vital to utilise in responding to the required change. Also seen during the 1980s – in our view – was an ***overemphasis*** on a complete and a far too mechanistic modelling of the way business is conducted.

During the 1990s the key management tool for change became "Business Process Re-engineering (BPR)". BPR implementation aims to re-engineer old business processes, organisational structures and practices that became inappropriate for the new rapidly changing business challenges. But, lately BPR is no longer seen as a panacea; as many reporters maintain that only a third of BPR projects can be considered to be successful (see for example: Tapscott (1996)) Although the theory on which BPR is based is sound, the key failures are cultural, mainly because of people's resistance to change (such as a lack of executive support) as well as unrealistic expectations. Furthermore, the main goal for BPR was streamlining the business by reducing costs – mostly focussed on reducing head count. Therefore employees became sceptical towards programs introduced in the name of BPR. Re-engineering turns out to be a necessary but insufficient condition for competitiveness. The goal should be more than just cost control; rather a drastic transformation of customer service, innovation, and responsiveness to the challenges of modern times.[2] Today it is recognised that **success** in the new economy will require companies to follow a two-fold but interrelated approach:

> to invent new business processes, new businesses, new market places, and new customers – not just to re-engineering old processes; and
>
> (vitally for companies; and probably most importantly) to grow and exploit the intellectual assets of the organisation.

For a long time it has been recognised that **technology** – and specifically information technology – serves as a key **enabler** of business change and innovation**.** This insight has recently been expanded, in the sense that we now realise that technology can strategically be employed to become a key **driver** of change and innovation. Thus, it is not simply the case that needed change can be facilitated (enabled) by technology; rather, the very presence of technology stimulates (drives) a need for change. We can refer to many sources for this realisation, such as the numerous publications of respected industry observers and consulting groups such as Gartner Group and META Group, as well as the well-articulated perspectives of the necessity to align business and IT as far as strategy and execution is concerned[3]; the latter is however regarded as out of scope of this study. The diagram in Figure 1 illustrates the relationship between IT and business; the bottom right block depicting IT's enabling role, and the top right block, its driver role.

We will restrict ourselves here to discuss in summary just one notable report from the Gartner Group which is relevant to the subject of this study. The report relates to "***The Technology-Enabled Enterprise***" (Schlier, et al (1998)). It highlights, inter alia, the important role of knowledge and knowledge management in the early 21st century. The authors predict that the information technology (IT) professional will be faced with the challenges and opportunities caused by the heightened competition of a global economy. They write: "***No longer viewed solely as a tool of process efficiency and effectiveness in many industries IT will be a determinant of survival and prosperity***."

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[2] More detail out of scope of this study is covered in Tapscott (1996). See also: Table 1.1 on p30-31 of Tapscott (1996) which compares various attributes of Total Quality, Re-engineering, and Business Transformation approaches.

[3] For the classic article on Business and IT alignment, see: Henderson and Venkatraman (1993).

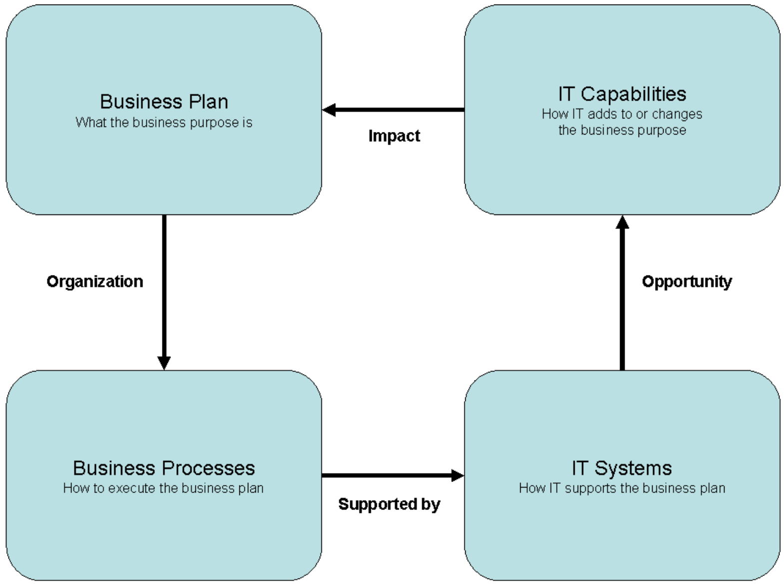


Figure 1: Business and IT Relationship

IT will become the competitive resource to differentiate and provide competitive advantage. The factors driving demand for IT in the new economy – with knowledge management as a prominent factor – are summarized by this Gartner report as follows:

- The emerging global economy – globalization;
- Dramatic changes in terms of competition;
- Competition-driven changes in enterprise strategy and structure;
- Enterprise critical success factors (CSFs);
- Continuous enterprise transformation; and
- **Knowledge management (KM).**

These drivers of demand will create new IT CSFs and drive the need for a new vision of IT architecture that reflects the realities of the successful enterprise of the early 21st century.

The use of technology – especially information technology – is changing strategic business expectations in terms of speed of execution, time limitations, reduction or even elimination of distance barriers, and perceptions of services delivered. The modern user, customer, or citizen has become increasingly demanding and expects to transact with business in a way that can mostly or even only be achieved via technology-based support systems. These systems are primarily integrated with processes and technology that is based on information, knowledge, and the knowledgeable people involved – the so-called knowledge workers[4].

[4] We discuss these aspects in detail later in this study.

1.2 The Knowledge Management Idea

The idea of "Knowledge Management" is a contemporary response to the challenges of the economy in the new millennium. Even though humankind has perennially relied on knowledge for solutions, the recent emergence of, and emphasis on Knowledge Management (KM) as a critical topic, is rooted in technological developments. More specifically, it is related to the ease of access and affordability created by new technologies, primarily the set of Internet-based technologies. Knowledge management is not an end in itself but rather a means to an end. Knowledge Management is considered a key part of the strategy to use expertise to create a sustainable competitive advantage in the present business environment. The contemporary enterprise faces a number of business drivers that seriously challenge the organisation's ability to survive and prosper. These **business drivers** and modern trends include:

- an overload of information and opportunities;
- a shortage of some resources and an abundance of others;
- increasing investment in people and information; and
- the resultant uncertainty in handling these issues when dealing with shrinking response times.

See for example a good coverage in Toffler (1991) as well as the well-respected publications of Malhotra (2003), Sunter (1992, 1996), Visser & Sunter (2002), Grulke (2000).

Central to an approach to counter these challenges, is the realisation of the importance of knowledge, both about the external business environment and about the available internal expertise. The strategic choice is a **knowledge-focused** evolving into a **knowledge-enabled** strategy: the more an enterprise's market value is determined by intellectual capital, the more knowledge-focused its strategic response should be to KM business drivers. A **key idea** in this regard is the following:

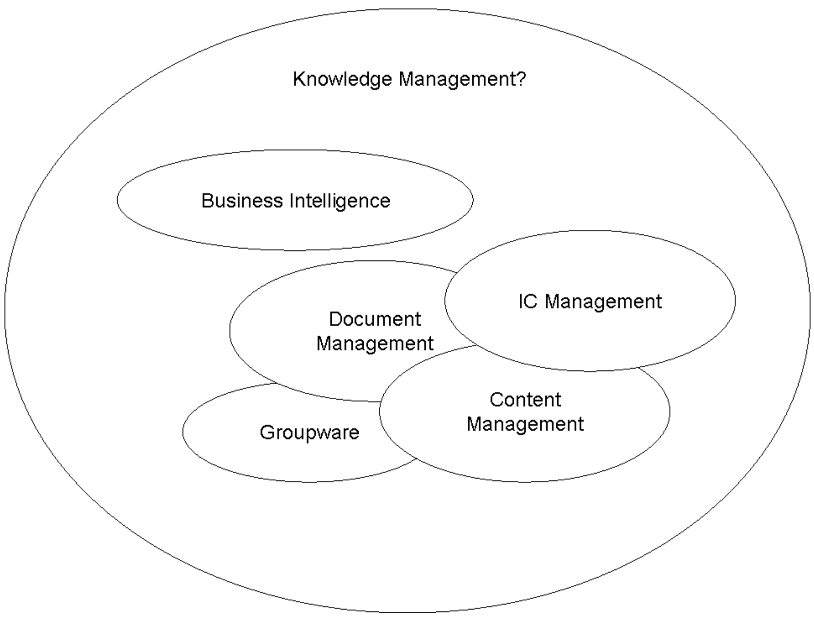
The major competitive advantage an organization has, is its knowledge expertise – it is the primary differentiator in a hugely competitive business environment.

It can thus be concluded that KM and related concepts and notions need to be understood firmly as well as effectively positioned and employed to support the modern business organisation in its quest to survive, grow, and prosper.

A large body of literature has emerged recently, covering KM and related topics; as well as technologies applicable to KM. See for example the numerous references listed in Liebowitz (1999) and Malhotra (2001). As another example, note that Bontis (2001) cites more than 200 references on the single sub-theme of managing aspects of intellectual capital.

However, various academic and practitioner approaches are still to emerge to clarify definitions, taxonomies for positioning KM, etc. At present there is **some confusion** amongst outsiders to the field as to what this KM phenomenon entails and how to comprehend various claims and issues related to it. Claims are made by the promoters of various technologies in order to fit their technologies into the current KM buzzword. A number of articles covering IT related subjects are also contributing to this confusion while treating the subject from different perspectives and adopting a multitude of "definitions" of the large body of notions and concepts in this subject area. Later we will explore these aspects in depth.

The following diagram illustrates some of the different notions that may be confused with the notion of KM.



1.3 About this Study

This study aims to contribute by clearing some of this confusion. It will do so by proposing a more comprehensible set of representative insights and frameworks. The approach taken is to research the vast literature on this topic and combine that with more than 38 years of active involvement, exposure, and experience both as academic and practitioner in the IT industry. This presented a baseline (and afforded the luxury) for being able to synthesise and critique many aspects of a fast evolving industry that is rapidly reaching maturity. This industry therefore gets involved with more fundamental and value-add contributions – technology as well as non-technology-based – for the modern knowledge-based business.

In the first part, this study investigates the concepts and elements, drivers, and challenges involved in KM. It describes various perspectives on the many notions in the field of KM. A set of models is proposed for comprehending the positioning, challenges and practical nature of KM.

Although KM is primarily concerned with non-technical issues **the study concentrates on the technical and technology issues and challenges**, and in the middle part distils out an initial technical framework for KM meant for practitioners such as consultants and implementers. By the term "technical and technology issues and challenges" we specifically mean to concentrate on the technologies and technical KM approaches a modern organization can employ to survive and prosper in this rapidly changing business environment.

In the last part of the study we focus on a specific area of study within the general KM arena – namely that of the so-called Enterprise Knowledge Portals. In doing so we synthesise many of the current confusing aspects pointed out in this study. Enterprise Knowledge Portals are a set of approaches, techniques, and technologies that modern enterprises can develop and employ to facilitate and improve the "management" of their knowledge capital and exploit the value of these assets.

This study contributes not only by resolving a number of unclear issues in the KM field but by simultaneously uncovering a number of unsolved issues for later study. We conclude therefore by listing a set of topics and issues that needs further research and study.

We accumulated and compiled a useful KM Glossary of frequently used terms and in the appendices a list of useful KM reference sources. These were not meant to be an exhaustive glossary and set of lists, but were meant to assist readers interested in this field of study.

Chapter 2 Knowledge Perspectives and Concepts

> ***It is ironic that the science of the 20th century is based on Relativity, Quantum Effects and the Theory of Chaos; and that we were guilty of not managing knowledge.*** – Anonymous

2.1 Background

The study of learning and of its key component, knowledge, dates back at least to the days of the philosophers Plato and Aristotle. Aristotle is quoted to have said: "***For the things we have to learn before we can do them, we learn by doing them.***" [5] Modern day thinkers, artificial intelligence scientists, and business management experts such as Peter Drucker, Alvin Toffler, and Ikujiro Nonaka have spent much time and energy in grasping the importance of knowledge, in creating an awareness of its value and of the vital need for its "management" in modern organisations. See articles and books such as Drucker (1993); Toffler (1976, 1981); Nonaka and Takeuchi (1995); Prusak (2001); Stewart (1997,2001); Tapscott (1996); Malhotra (2001,2003); Sveiby (2001a).

Prusak (2001) looks at the history of the subject area of knowledge management and offers insights into what knowledge management (KM) means today and where it may be heading in the future. He maintains that KM is a **practitioner-based response** to real social and economic trends which include the following three major trends, namely:

- Globalization;
- Ubiquitous computing; and
- The knowledge-centric view of the organization.

Globalization has introduced unprecedented complexity, large volumes of global transactions, as well as an ever increasing change in the business environment. It has added an increasing number of new participating players, products, as well as channels for access and distribution. These can only be effectively handled by information technology infrastructures, support tools and systems. Organizations are forced to ask themselves, in Prusak's words:

"What do we know, who knows it, and what do we know that we should know? "

The trend towards ubiquitous computing increases the unintended value of that specific knowledge that cannot be digitized, such as judgement, design, leadership, better decisions, innovation, and humour. The virtually unlimited access to all digitized information at today's low cost of communication has raised the value of those skills that cannot be digitised. The contemporary view of an organization is that although it embodies a collection of capabilities, it is constrained in its effectiveness by its current cumulative skills and know-how – its **knowledge assets**. These

[5] See online quotes Web site: www.quotations.about.com (accessed in April 2005).

capabilities are mostly built from the tacit and explicit knowledge that exist in the organization and turn out to be a major competitive differentiator in the new society.

Most of the content, emphasis on, and energy for KM originated from the three preceding eras, namely:

- The information management era;
- The quality movement; and
- The human capital era.

Information Management is the approach and practice that focuses on how information is managed – independently of the information technologies. The information considered here consists of documents (in various formats and media), data, and structured messages. Similar to information management, knowledge management shares a user perspective – i.e. it focuses on value as a function of user satisfaction rather than on the efficiency of the technology that handles the information. It also focuses on the quality of the content.

The quality approaches of the 1980s and 1990s focused on internal customers, improving processes, and shared goals. Quality management was most effective for manufacturing processes. KM has a broader scope in that it includes processes that do not seem to lend themselves to measurement or even to clear definition.

The human capital approach has a sound theoretical base. In practice though, the understanding of the value of human capital is not yet well-established. The view is mostly on the financial advantage of investing in individuals through education and training. But, many organizations still view their employees and their education as expenses rather than investments. By definition, human capital focuses on the individual, whereas KM work is concerned with groups, communities, and networks (Prusak, 2001).

2.2 Varieties of Knowledge

Nonaka pointed out that knowledge comes in two basic varieties: **tacit** and **explicit**[6]; or to put it differently: as un-codified knowledge and codified knowledge (Nonaka, 1991; Nonaka and Takeuchi, 1995)[7]. We realize that a number of authors criticized Nonaka on philosophic grounds in this respect, pointing out that knowledge in essence cannot purely be represented explicitly. These views consider the duality of knowledge as being an interlinked mixture of implicit (tacit) and explicit knowledge. In fact the duality of knowledge implies that tacit and explicit knowledge are co-dependent and any view of knowledge involves both tacit and explicit knowledge. See for example

[6] The word tacit comes from the Latin, meaning "to be silent or secret". Explicit, also from Latin, means "to unfold" – to be open, to arrange, to explain. It almost means "to document". (Stewart, 2001)

[7] The classic (philosophical) works on tacit knowledge are: M. Polanyi's (1957): ***The Tacit Dimension***, Doubleday, New York and M. Polanyi (1984): ***Personal Knowledge***, University of Chicago Press.

Hildreth and Kimble (2002), and Liebenberg (2003). A practical view of knowledge is that tacit and explicit knowledge are not absolute opposites, but that they form a spectrum. Understanding them is best achieved at the extremes of this spectrum. We agree in principle that knowledge is essentially a pure human faculty which is still far from being completely understood. But, we also recognise the importance of the contribution that Nonaka made to this study area to shift the focus away from a philosophical-only view towards a much more practical business view. Our approach in this study is to employ the view of Nonaka cautiously and avoid falling into the same trap as many academics and practitioners by confusing the notions of "information" versus "knowledge" as well as "information management" versus "knowledge management".

According to Nonaka, explicit knowledge comes in the form of artefacts such as books, documents, white papers, databases, and policy manuals. Tacit knowledge, in contrast, can be found in the heads of employees, the experience of customers, and the memories of stakeholders. Tacit knowledge is hard to catalogue, highly built on experience, difficult to document in any detail, and may be short-lived. Both types of knowledge are important and according to Nonaka it is the interaction between tacit knowledge and explicit knowledge that creates learning in the organisation. The organisational learning process involves capturing, exchanging and creating the knowledge in a continuous interaction of these two knowledge varieties – a never-ending, closed-loop knowledge transformation process.[8] This concept is illustrated in the diagram of Figure 2.

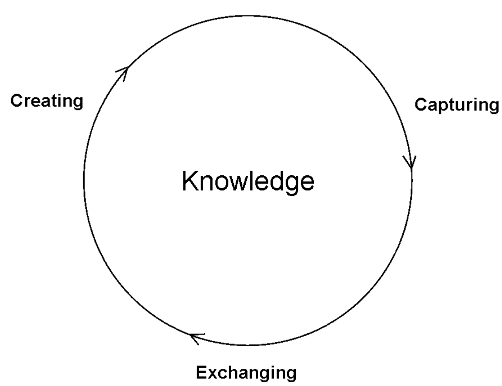


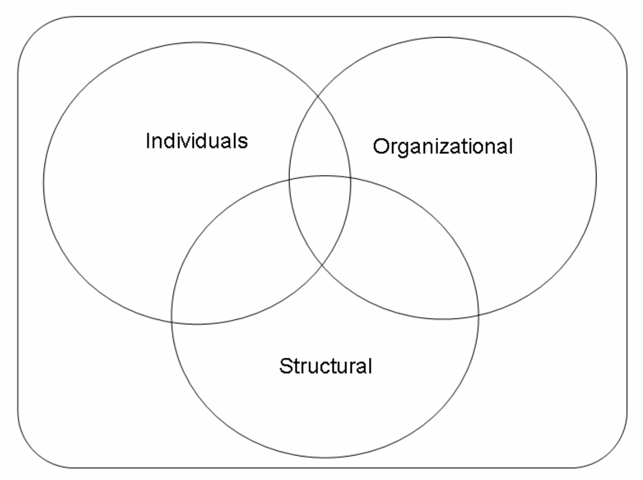
Figure 2: Organizational Learning Process

Business knowledge may also be divided into individual, organisational, and structural knowledge. Individual knowledge resides only in the minds of the employees. Organisational knowledge results from the learning that occurs on a group level or division level. Structural knowledge is embedded in the culture and make-up of the organisation through processes, manuals, business rules, and codes of conduct and ethics. It should be noted that all of these types of business knowledge can also be classified as either tacit and/or explicit (Tapscott(1996) and Stewart(2001)).

The following diagram illustrates this notion.

[8] More detail is discussed later in this study.

Business Knowledge



Knowledge is also broader than the notion of intellectual capital (IC). IC refers to the commercial value of trademarks, licenses, brand names, formulations, methodologies, intellectual content, and patents. Knowledge is broader in that it is also dynamic as a result of action and interaction between people in an organisation using information, knowledge, and learning while interacting with each other[9].

Knowledge is much more than just information, although it is only a **special form** of information (Firestone, 2003). Only when information is being used by people, can it be transformed into or regarded as knowledge. With the modern overload of information one can have too much information; but it is hard to conceive that one can have too much knowledge[10].

Hence, as a ***first take practical*** approach to comprehend the notions of data, information, and knowledge – summarising many references in the literature – the following view is proposed[11]:

- Knowledge is actionable information;
- Information is organised / analysed data; while
- Data consists of facts and figures having no meaning out of context and interpretation.

– – – – – – –

Following this introductory view of the notion of knowledge we explore in the next section the **knowledge concepts** in more depth.

[9] The notion of IC is described in more depth later in this study.
[10] "At this point Festus interrupted Paul's defence. "You are out of your mind, Paul!" he shouted. "Your great learning is driving you insane." – Acts 26:24
[11] We will analyse, use, and debate this general notion of knowledge later.

2.3 Knowledge Concepts

Knowledge is of two kinds: We know a subject ourselves, or we know we can find information upon it. – Samuel Johnson

Wisdom consists of knowing what to do with what you know. – Anonymous

2.3.1 Introduction

In this section we describe the basic concepts and nature of knowledge. We start this review and seek the opinions of various authors in various disciplines of study; later on, we attempt to clearly define the notion of "knowledge" in its current context as well as identify different types of handling knowledge. We contribute by interpreting with our own insights and ideas about the notion of knowledge.

Stewart (1997) writes:

> ***"It is a defining fact about organizations in the Information Age: Knowledge and information take on their own reality, which can be detached from the physical movement of goods and services. From this divergence comes at least two important implications. First, knowledge and the assets that create and distribute it, can be managed, just as physical and financial assets can be. Indeed, intellectual and physical-financial assets can be managed separately from one another; they can be managed together; they can be managed in relation to one another. Second: If knowledge is the greatest source of wealth, then individuals, companies, and nations should invest in the assets that produce and process knowledge."***

However, while practicing in IT consulting situations the author was often exposed to the many viewpoints of different people who have vested interests in viewing the concept of knowledge from their respective expertise domains. This can be summarised as follows:

- For human resource management: "***knowledge can only be in the minds of people***";
- For document management and librarians: "***knowledge is in documents***";
- For information system management: "***knowledge management is information management with the word information changed to knowledge***"; and
- For knowledge engineering: "***knowledge is something which can be captured in computer applications***".

It therefore seems worthwhile to examine the concept of knowledge more clearly.

2.3.2 Some Ideas about the Term Knowledge

According to Snowden (1998): "***It is not necessary, realistic or sensible to devote time to defining knowledge. What is important is to achieve an understanding of what is meant to use knowledge in contrast to information.***" Notwithstanding this view, this study proceeds from the view that we should at least grasp the complexity of the term "knowledge" and relate it to the term "information". Because the notion of knowledge is complex, various attempts have been published to better grasp the notion. Snowden falls back on "story telling" – an age-old strategy – which has its application in a very general context, but which does not define the term well enough in order to devise technical tools or to judge the applicability of the technical aspects of knowledge management.

Sidebar:

Stories are not just something that we read to put ourselves and our children to sleep, nor just something we read in literature classes. Rather, they are the things that lay at the heart of human intelligence. To understand intelligence, we need to understand stories: their structure, their acquisition, their retelling.

- Robert Sternberg, quoted in New York Times Book Review (Reader's Digest May 1992)

Sidebar:

Snowden (1998) uses the metaphor of a map and a guide to distinguish between knowledge and information***: "A map is a set of data organised into a coherent and reusable form – it is information. The guide, on the other hand, is knowledgeable. She does not need to consult a map, takes into account recent experience and has the ability to relate my ability to her knowledge of the terrain. The guide is the fastest way to achieve my objective, provided that I trust her. If I do not have that trust, and am not prepared to take a risk of experimentation, then I will fall back on information – the map."***

Authors in Artificial Intelligence (AI) and especially Expert Systems – also known as "knowledge engineering" – came to an association between knowledge and expertise (Luger and Stubblefield (1989)). Waterman (1986) articulates this as follows:

> "***The goal of AI scientists had always been to develop computer programs that could in some sense think, that is, solve problems in a way that would be considered intelligent if done by a human … Various attempts over a number of decades were made to achieve this goal. In the late 1970s AI scientists began to realize something quite important:***
>
> > ***To make a program intelligent, provide it with lots of high-quality specific knowledge about some problem area.***

This realization led to the development of special-purpose computer programs, systems that were expert in some narrow problem area."

These programs are known as ***expert systems***. The process of building expert systems is referred to as ***knowledge engineering***. The expert in this case is a human expert:

"***An expert is a person who, because of training and experience, is able to do things the rest of us cannot; experts are not only proficient but also smooth and efficient in the actions they take. Experts know a great many things and have tricks and caveats for applying what they know to problems and tasks; they are good at ploughing through irrelevant information in order to get at basic issues, and they are good at recognizing problems they face as instances of types with which they are familiar. Underlying the behaviour of experts is the body of operative knowledge we have termed expertise.***" (Waterman,1986)

Expert Systems rely on a corpus of knowledge. The knowledge is derived or captured from the expertise of human experts - sometimes without the capturers realizing/grasping the imbedded semantics and implications of the knowledge items. The knowledge is explicit to the expert system and organized to simplify decision making. The knowledge is explicit and therefore also accessible (unlike most conventional programs).

Thus, a first conclusion we can derive for this study from AI and expert systems is that **human knowledge** is closely linked to the **notion of expertise**. It is highly personal and difficult to transfer or document as the expert often finds it difficult to express the reasoning behind his/hers expertise. This thinking of the 1980s and 1990s was based on the premise that knowledge is “nothing but” a set of rules, and that knowledge engineering was about getting these rules from the heads of experts into expert system shells. Some authors maintained optimistically that all human knowledge could eventually be encapsulated in vast “knowledge bases”. This is a very mechanistic view of the concept of knowledge. Today we realise that this view is far from the abilities of human beings; humbling us in grasping the limitations of our current technologies compared to human cognitive capabilities.

The study of expert systems taught us a number of valuable lessons that are applicable to this study. In some cases artificial expertise located within an organisation is preferred to human expertise; in other cases the reverse is true. One advantage of artificial expertise is its permanence. Human expertise can quickly fade, and must constantly be practiced and rehearsed to maintain proficiency in some problem area. Artificial expertise is usually more applicable to and useful in narrow domains of knowledge. To replicate in an expert system the human ability of a broad focus and deployment of commonsense knowledge, is still just a distant dream for the expert systems builders of today. Other characteristics sometimes considered to differentiate artificial from human expertise are listed in Table 1 and Table 2[12].

[12] Adapted from the classic work of Waterman (1986)

Human Expertise	***Artificial Expertise***
Perishable	Permanent
Difficult to transfer	Easy to transfer
Difficult to document	Easy to document
Unpredictable	Consistent
Expensive	Affordable

Table 1: Artificial Expertise preferred to Human Expertise

Human Expertise	***Artificial Expertise***
Creative	Uninspired
Adaptive	Needs to be told
Sensory experience	Symbolic input
Broad focus	Narrow focus
Commonsense knowledge	Technical knowledge

Table 2: Human Expertise preferred to Artificial Expertise

Human expertise relies on **Human Intelligence** and the knowledge that a human applies to become and remain an expert. There exists a fascinating interplay between intelligence, knowledge, learning, language, memory, and the unique abilities of human behaviour such as understanding, recognition of patterns, and ability to abstract and generalize. A number of these topics are areas of study in Artificial Intelligence, Psychology, Education, etc.; however we are touching them here because they overlap with the focus of knowledge management.

We will concentrate here first on the more abstract notion of **knowledge versus information**. At a very basic level, we may distinguish between knowledge, information and pure data by referring to their abstraction levels. Although Snowden (1998) does not promote or support this approach such a distinction nevertheless gives us some insight into the notions of data, information, and (explicit) knowledge - as in the accompanying representation. We differentiate here between three types of knowledge, namely explicit knowledge, tacit knowledge and imbedded knowledge as illustrated in Figure 3[13].

This representation as different abstract levels by no means indicates a dependence of knowledge on (pure) information. There is a co-dependence between knowledge and information although the human expert often cannot express the specific information on which some knowledge may depend, and also often has no clear wording or formulation of the reason for a particular decision or action - which was taken because of certain expertise, knowledge or intuition.

[13] The idea and content was adapted from a variety of sources including IBM presentations on e-business.

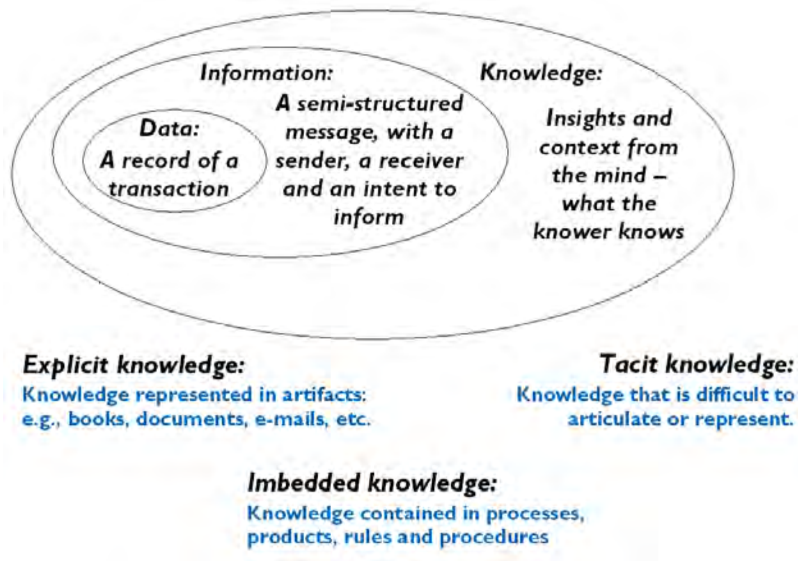


Figure 3: Knowledge, Information, and Data

Turban and Frenzel's (1992) definitions of data, information, and knowledge in AI are:

Data - The term data refers to numeric (or alphanumeric) strings that by themselves do not have a meaning. They can be facts or figures to be processed.

Information - is data organized so that it is meaningful to the receiver of the information.

Knowledge - has several definitions. In the dictionary definitions the term knowledge is:

- A clear and certain perception of something;
- Understanding;
- Learning;
- All that has been perceived or grasped by the mind;
- Practical experience and skill;
- Acquaintance or familiarity;
- Cognizance; recognition; and
- Organized information applicable to problem solving.

Table 3 illustrates the differences in characteristics between the notions of information and knowledge.

Information	**Knowledge**
Information is linked to data	Knowledge relates to data and information but may not be linked to it
Quantity: lots of information	Much less knowledge
Information is sometimes context based	Knowledge is always context-based
Information can be created by people and computers	Knowledge can only be created by people
Information is easier to understand and transfer	Knowledge is sticky and is very context based
Information is often static	Knowledge is often dynamic
Information is single loop learning	Knowledge is double loop learning
Information can be easily linked	Knowledge requires a framework to make sense
Information is costly to create and maintain	Knowledge is more costly to create and maintain
Information can be used by anyone anytime	Knowledge often has time and target value

Table 3: Information versus Knowledge

Sowa's (1984) definition is: "***Knowledge encompasses the implicit and explicit restrictions placed upon objects (entities), operations, and relationships along with general and specific heuristics and inference procedures involved in the situation being modelled."***

The ability to form ***higher-level abstractions*** from the particulars of experience, is one of the most powerful and fundamental abilities of the human mind. Abstractions allow us to understand the full range of instances in a domain. Luger and Stubblefield (1989, 1993) articulate this well as follows:

> "***A picture may be worth a thousand words, but an abstraction can define the important features of an entire class of pictures. ... Ultimately, most of our ideas are about other ideas.***"

Knowledge as used by a computer consists of facts, concepts, theories, heuristic methods, procedures, and relationships. Knowledge in this context is also information that has been organized and analysed to make it understandable and applicable to problem solving or decision making. This angle on the notion of knowledge is inherently covering a representable type of knowledge - the so-called explicit knowledge.

In businesses and organizations in general we encounter knowledge in mainly three forms:

- **Explicit knowledge** as represented in databases, memos, notes, documents, etc.;
- **Imbedded knowledge** which is encountered in business rules, processes, manuals, in the organization's culture, codes of conduct and ethics, etc.; and
- **Tacit knowledge** which is present in the minds of human stakeholders.

We will have to distinguish between these knowledge types in order to fathom the richness and vital importance of knowledge for the survival of modern organizations. The modern emphasis is on realizing the importance of knowledge and on managing the knowledge assets in an organization. Refer to Figure 4 for a diagram of the hierarchy of these 3 types of knowledge within organizations; and how they relate to the values, norms and culture of the organization. See also previously mentioned Figure 3 on page 21.

Note: In the rest of this study we will use only the two forms – tacit and explicit – and draw no distinction between explicit and imbedded knowledge.

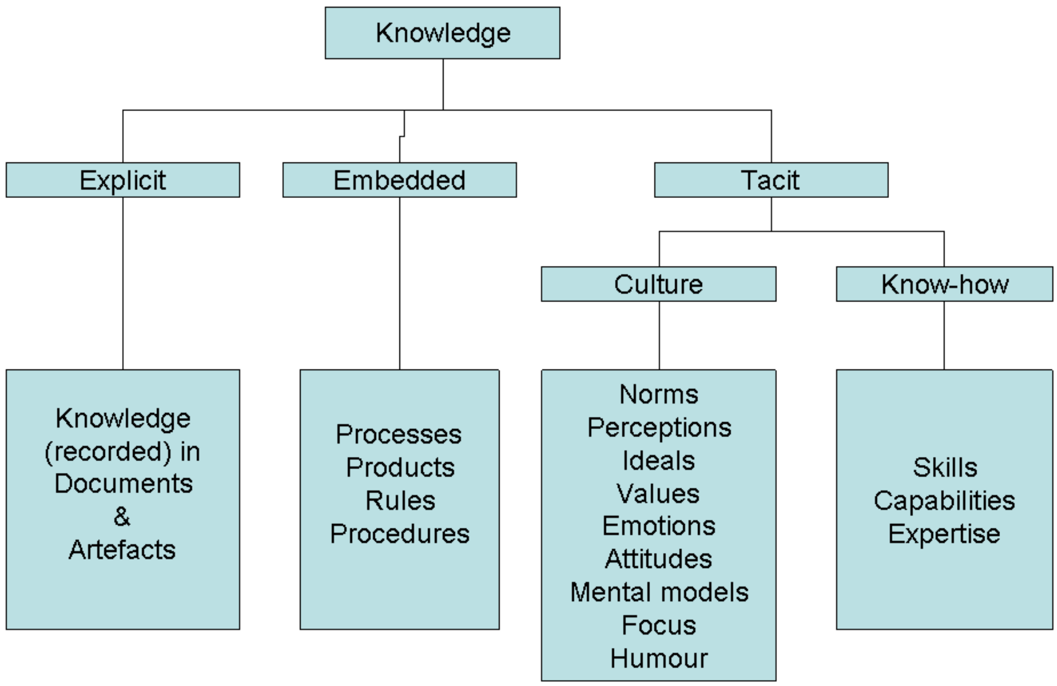
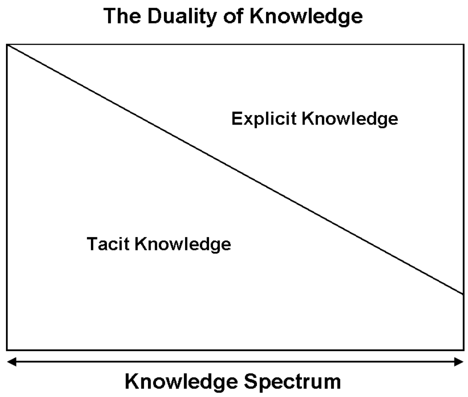


Figure 4: Three Varieties of Knowledge

The process of using data and information as well as of acting upon it creates knowledge. Knowledge is an individual's or organization's understanding of reality – of what works and what does not work. Knowledge can be seen as a **spectrum** ranging from pure tacit know-how, competence, expertise, values, and norms to mostly explicit interpreted knowledge. The notion of knowledge is best understood at the extremes of this spectrum. In most cases where we deal with knowledge we have to consider the ***duality of knowledge*** – a combination of tacit and explicit. This is illustrated in the following diagram. Therefore, knowledge can be purely tacit knowledge or a combination of tacit and explicit knowledge. This differentiates knowledge from (pure) information.

We close this section by positioning different types of knowledge that occur within an organization.



2.3.3 Different Types of Knowledge

For our practical and technology approach to the subject, we recognise and differentiate between five different **types of knowledge**, namely[14]:

1. **Know-what**: refers to knowledge about facts or some truth; also known as ***declarative knowledge.*** An example of declarative knowledge is knowing certain facts such as who the president of the World Bank is or that the world is a globe and not flat; as well as what that means and implies.
2. **Know-why**: refers to knowledge about principles and laws in nature, the human mind, and society. It involves deep knowledge of cause-and-effect relationships.
3. **Know-how**: refers to skills – i.e. the ability to do something; that is to apply "know-what" knowledge to complex real-world problems. This is also known as procedural knowledge. In procedural knowledge, there is an end goal that requires a series of steps to be accomplished, with the execution of those steps driven by internal procedural rules. Procedural knowledge can vary in complexity from simple, such as selecting personal computing functions when utilising a keyboard, to very complex, such as riding a bike. Most procedural knowledge is tacit – it can not be articulated.
4. **Know-who**: involves information about who knows what and who knows what to do. It is typically a kind of knowledge developed and kept within the boundaries of a group such as an organization or community of practice. As the complexity of the knowledge increases, co-operation between groups tend to develop and people build respect and understanding of who knows what and who to approach for specific knowledge.
5. **Know-when:** refers to knowledge involving timing. One of the most valuable types of knowledge in a business context is ***predictive knowledge*** – the ability to look ahead to a certain condition and adjust before that condition occurs. Also valuable is ***adaptive knowledge*** – the knowledge that guides an organization to change itself when the business environment demands it.

These types are illustrated in Figure 5.

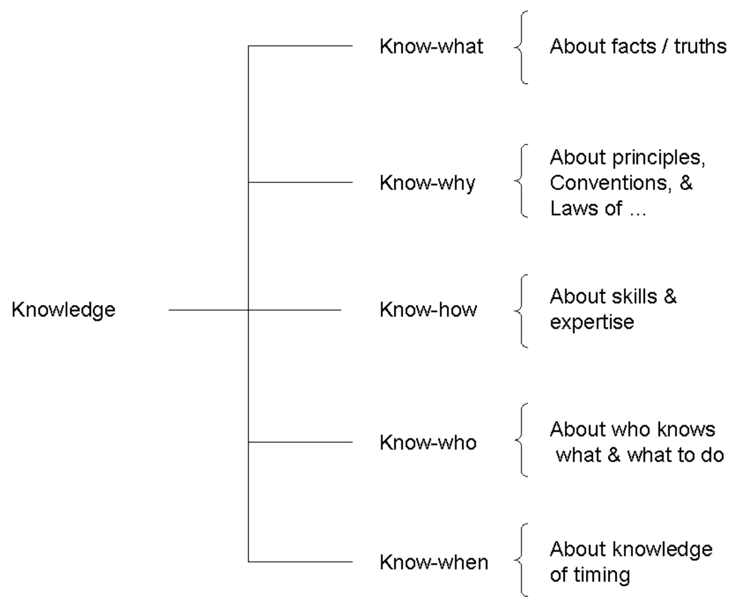


Figure 5: Five Types of Knowledge

The knowledge worker and innovator are continually involved in learning and experimentation with the goal to move from superficial knowledge to deep understanding. The distinction is between **knowing how** things are done and **knowing why** they occur. As Garvin (1993) states:

> "***Knowing how is partial knowledge; it is rooted in norms of behavior, standards of practice, and settings of equipment. Knowing why is more fundamental: it captures underlying cause-and-effect relationships and accommodates exceptions, adaptations, and unforeseen events. The ability to control temperatures and pressures to align grains of silicon and form silicon steel is an example of knowing how; understanding the chemical and physical process that produces the alignment is knowing why***."

This view of knowledge should be seen as the baseline of how knowledge will be regarded in the rest of this study; namely as a duality of tacit and explicit knowledge – which is best comprehended at the extremes and where our particular emphasis is more on the explicit side.

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There is a reason to believe that the greatest advantage from the use of knowledge will come from topics where the knowledge that exists, is generally not explicitly available. In many cases this knowledge is only in the heads of individuals and has not been captured for use by others. To take advantage of this tacit knowledge, enterprises try to capture and convert it into ***explicit knowledge*** that others can access and take advantage of.

A much referenced approach to how this can be done in practice can be articulated in terms of the "**Knowledge Conversion Life Cycle**" which is the topic of the next section.

[14] We utilise here sources such as adapted from tutorials of (eKnowledgeCenter.com) as well as (van der

2.4 The Knowledge Conversion Life Cycle

Nonaka and Takeuchi published their highly influential book "***The Knowledge-Creating Company***" in 1996 which may rightly be considered to be the main trigger for the business focus on the value of knowledge management. They made a number of contributions to this subject area that many authors consider to be valuable. Here we are only interested in **their Knowledge Conversion Life Cycle Model**.

We discuss some extracts from an overview of Nonaka's (1991) article that predates the book as applicable in this context:

> ***"The knowledge-creating company is as much about ideals as it is about ideas. And that fact fuels innovation. The essence of innovation is to recreate the world according to a particular vision and ideal. To create new knowledge means quite literally to recreate the company and everyone in it in a non-stop process of personal and organizational self-renewal.***
>
> ***In the knowledge-creating company, inventing new knowledge is not a specialized activity. It is a way of behaving, indeed a way of being, in which everyone is a knowledge worker …***
>
> ***New knowledge always begins with the individual … {In each case} an individual's personal knowledge is transformed into organizational knowledge valuable to the company as a whole. Making personal knowledge available to others is the central activity of the knowledge-creating company. It takes place continuously and at all levels of the organization."***

As mentioned previously Nonaka and Takeuchi (1996) suggested that **two types of knowledge** exist, namely **tacit** and **explicit**. The following table lists more detail.

Tacit Knowledge	***Explicit Knowledge***
Knowledge of experience (body skills) Simultaneous knowledge (here and now) Analogue knowledge (practice)	Knowledge of rationality (mind) Sequential knowledge (there and then) Digital Knowledge (theory)

It is valuable to relate the two types of knowledge - tacit and explicit - in a 2x2 tabular form to derive the "Knowledge Conversion Life Cycle" of Nonaka and Takeuchi.

These four patterns of knowledge creation in an organization are closely linked in a **knowledge creation cycle of learning**. This knowledge creation and learning cycle termed "**knowledge conversion"** is presented in the following table.

Spek and Spijkervet (1996) and Quinn, et al (1996).

Knowledge Conversion	***Tacit Knowledge***	***Explicit Knowledge***
Tacit Knowledge	Socialisation (Sympathised knowledge)	Externalisation (Conceptual knowledge)
Explicit Knowledge	Internalisation (Operational knowledge)	Combination (Systemic knowledge)

It can be regarded as **a never-ending cycle**: identifying tacit knowledge; making as much of it as possible explicit so it can be formalized, captured, and leveraged; encouraging the new knowledge to be absorbed and become tacit (Stewart, 1997). In the knowledge-creating company, all four of these patterns exist in a dynamic interaction – a kind of "spiral of knowledge" (Nonaka, 1991). This is illustrated in Figure 6 in a simplistic view; because many other views are also possible.

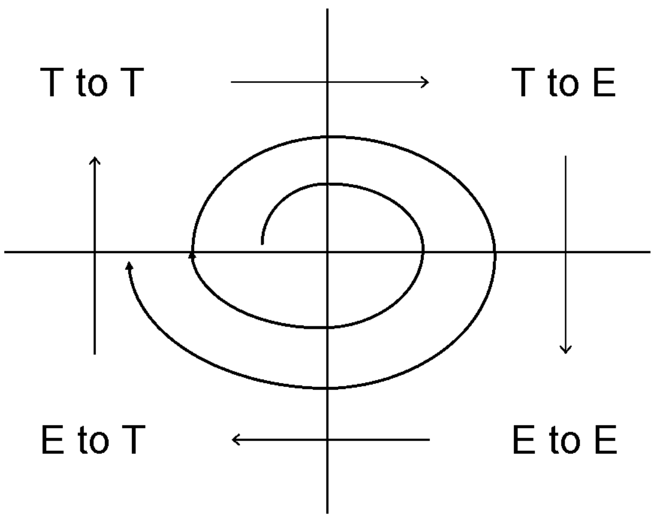

Figure 6: Knowledge Conversion Cycle (simplistic view)

These **four different patterns** are summarised as follows:[15]

From **Tacit to Tacit** – Socialization / Sharing – This pattern enables the learning of skills through observation, imitation, and practice, making the skills part of one's own tacit knowledge "base" – thus learning through a "socialization" process. Knowledge is the by-product of experience and interaction. We learn by assimilating meaning from and remembering our dynamic interactions and experiences. This is still a limited form of knowledge creation because the knowledge seldom becomes explicit and can therefore not easily be leveraged by the organization as a whole.

From **Tacit to Explicit** – Externalisation through Capture / Articulation – This exchange converts tacit into explicit knowledge, allowing it to be shared and exploited by others in the company.

[15] Sourced from various sources including the online source: www.serviceinnovation.com (accessed: April 2005).

From **Explicit to Tacit** – Internalization / Learning – As new explicit knowledge is shared and made available throughout the company, other employees begin to "internalize" it – in other words: they are broadening, extending, and reframing their own tacit knowledge. In this way the organization is continuously updating its knowledge base and the knowledge workers use it as part of the background of tools and resources needed to perform their jobs.

From **Explicit to Explicit** – Combination through Copying and Distributing – This is combining discrete pieces of explicit knowledge from different sources to form new knowledge which is the main task of the knowledge worker.

The Knowledge Life Cycle is a powerful model for KM. It clearly indicates that KM should at least be concerned about managing the opportunities for enabling the sharing, capturing, learning, and distribution of knowledge. As we are focussing in this study on the technical aspects of KM, we need to consider technical infrastructure as well as representation and support technologies to enhance these abilities. In the last part of the study we shall focus in detail on these support technologies and utilise the Knowledge Life Cycle Model extensively. In Table 4 we summarize and combine these aspects and hint at some of the relevant technologies.

Knowledge Conversion	**Tacit**	**Explicit**
Tacit	Socialization Sharing Meetings and discussions Chat rooms / synch. collaboration Informal e-mail Conferencing tools e-meetings Synchronous collaboration (chat)	Externalization Articulation; Capturing Write a report Authoring tools Collaborative filtering Capture information in course of work Answering questions Annotation
Explicit	Internalization Learning Learn from a report Summarization, navigation Detect & visualize relationships Personalize task & context Visualization Browsable video/audio presentations	Combination Copying; Distributing e-mail a report Current awareness - subscription Content maps for Knowledge browsing Organize or classify content or people Advanced text search Document categorization

Table 4: Knowledge Conversion Life Cycle

However, at this point we elaborate on a theme just mentioned in the previous paragraph: the need for managing knowledge. This is the topic of the next section.

2.5 Why Knowledge has to be Managed

In a global economy, knowledge may be a company's greatest competitive advantage. …
If you're renting knowledge, make sure you take steps to retain it too. …
What sounds like workplace gossip is often a knowledge network updating itself.
– Davenport and Prusak (2000)

The best brains on a particular subject frequently are spread around the world. The system that best unlocks its collection of minds will be the one that wins in the marketplace. – Robert Buckman, Buckman Laboratories

Knowledge Management alone is not the value. The value is winning in the marketplace.
– Todd Garrett, Senior Vice President, Chief Information Officer, Procter & Gamble Company

Knowledge plays a vital role for the existence and survival of organisations in the modern knowledge-based economy. As this study area is all but simple, we need to take cognisance of **various aspects** that affect the acceptance, necessity, and eventual adoption of KM in the modern business. These aspects include the following:

- There is a strong drive within modern organisations to become so-called learning organisations;
- There is a need to manage the knowledge assets and intellectual capital of the organisation;
- Various practical matters have to be considered, such as:
  - How to "manage" knowledge; or – at a minimum – how to raise awareness of its value and its unique nature
  - How to obtain, discover and apply knowledge and where its best practices fit
  - How to encourage and drive the sharing of knowledge within the enterprise;
- There is a need to devise a set of frameworks and models for KM; and
- It is of interest to critically assess predictions about KM and to therefore obtain a glimpse of the future of the field.

People know more than they realise; over the years they develop large internal "repositories" of skills, information, and ways of approaching challenges, and how to get things to "work" or "work out". Organisations too are stacked with explicit knowledge: various rules of thumb, values, intuitions, various rules of behaviour, etc. As was seen with the history of Total Quality Management, tacit knowledge is unexpressed, it is often unexamined; it can go wrong without one's being aware of the fact. Stewart (1997) articulates it well:

"***The outstanding virtue of tacit knowledge is that it is automatic, requiring little or no time or thought. But every virtue has a set of reciprocal vices, and tacit knowledge has three: It can be***

***wrong; it's hard to change; and it's difficult to communicate (author's emphasis). Tacit knowledge tends to be local as well as stubborn, because it is not found in manuals, books, databases, or files. It is oral*.**"

Knowledge is regarded as a vital asset of the modern organisation. In most cases knowledge manifests itself as the only real differentiator between organizations; in terms of the organization's capabilities, responsiveness or agility, adaptability to change when needed, adding value to customers and all stakeholders, etc. Because knowledge is so vital as an asset of the organisation it has become mandatory to manage knowledge properly. This is however not generally recognised, as many organizations do not embark on programs and strategies to manage their knowledge assets. The reason for this phenomenon is the lack of realization of the importance of knowledge, mixed and confused with the subtle differences between information management and knowledge management as disciplines and strategies.

Only in the last number of years is KM becoming regarded as a critical success factor for the modern organization's survival after many recent attempts at tackling similar and related issues on a strategic and operational level. One of the main contributors to this has been a growing realisation of how businesses themselves may be negatively affected by staff lay-offs and knowledge worker resignations.

Many strategists are careful in selecting yet another "***management fad***" as so many recent strategic promising management tools turned out to be just that. During the 1980s and 1990s many highly praised management tools such as "Total Quality Management", "Business Process Re-engineering", "Scenario Planning"[16], etc. were tried with varying degrees of success.

Since about 1996 the strategists have focussed on the discipline of KM[17].

Knowledge management not only has the primary task of making the right knowledge easy to find, but to locate, validate, and share any knowledge contained in the organization.

Knowledge Management (KM) is therefore a deliberate strategy to get the right knowledge to the right people at the right time to assist the employees and other stakeholders to share and put information and knowledge into action so as to improve organizational performance.

KM is not a radical paradigm shift as such. It is rather a framework and a changed focussed mindset to build on past experiences and to create new ways of exchanging knowledge. The past focus and experiences were mostly based on managing explicit knowledge kept in artefacts as well as tacit knowledge present in clever people. The new ways of exchanging knowledge are

[16] See Ilbury and Sunter (2003)
[17] It is however still very early to judge success or failure.

happening in communities of practice and competencies, knowledge-rich intranet sites, and rich collaboration between the stakeholders.

KM is primarily a ***multi-disciplined area*** of study and practice. It is mostly a concern of management science and business management. But, in the modern world these disciplines are intimately involved, and closely linked and supported by technology – especially information technology. KM is about managing knowledge as one of the most vital assets of the organisation; about creating a learning organisation that can adapt in an agile manner; thus: KM is mostly about **leveraging knowledge** in order to adapt to change, in order to survive and grow the organisation. Information technology is perceived to be the prime enabler of organizational change and innovation – especially in offering support with vital infrastructure and tools to ease and speed up the ability to manage the knowledge assets while coping with rapid change.

For most organizations the adoption of a knowledge-focussed strategy represents a transformation and requires a shift in the culture (i.e. values and focus) of the organization. It requires a shift in focus from[18]:

Individual	to	Team
Activity	to	Results
Completion	to	Evolution
Escalation	to	Collaboration
Content	to	Context
Knowing	to	Learning

The organization must shift to a perspective that sees knowledge as an asset owned and maintained by the team, not by an individual. The focus of the team is to capture and improve the collective knowledge; not just to solve individual customer problems, but to improve organizational learning.

These insights have led businesses to seriously consider "managing" their knowledge assets and answer questions such as the following:

- How is knowledge shared? This is particularly pertinent because of the trend of knowledge workers becoming more mobile.
- How is knowledge retained? Businesses have to consider trends such as downsizing and retrenchments.
- How is knowledge obtained? This is important because of the rapid business change currently occurring in the new economy.

[18] Sourced from: Whitepaper of Consortium for Service Innovation

2.6 Miscellaneous Insights about Knowledge

***We don't know what we know until someone asks us.* – David Snowden**

Companies don't own the knowledge ... at best, they lease it from the employees.

– Hubert Saint-Onge

In this introductory part of the study we described the richness of the notion of knowledge from various perspectives and conclude here with a few summary statements about the uniqueness and counter-intuitive nature of the term "knowledge".

Knowledge is unique and different from capital, labour, and land – the key ingredients of the "old" economy – in important ways, such as (Coleman, 1997):

- Ability to multiply
  If knowledge is shared it belongs to all who share. "Sell it or give it away and you still have it!" (Coleman, 1997)
- Knowledge costs little to reproduce but costs a lot to create.
  Sending a message on the Internet is virtually free.
- Knowledge is difficult to measure, weigh, or count.
  Measurement is only done in very indirect ways – such as the number of patents issued.
- Knowledge has a "time value" which is a key characteristic.
  Knowledge and insight hold value only for a short time – they must be replenished.
- Knowledge comes in several varieties – tacit and explicit – which have the following characteristics:
  Tacit
  – owned by individuals and very personal
  – is a set of skills, understanding, experience, and insights
  – also imbedded in products or in the company's processes
  Explicit
  – can be owned by organizations, individuals, or groups
  – can be recorded or can be described
  – documentation is often in electronic form in corporate documents, PCs, or on the Internet.

A few things we have learned about knowledge that may seem **counter-intuitive** can be summarised as follows[19]:

- Knowledge is not pristine, it is messy and chaotic.
  How well organized is our own knowledge?
- It is not static, it is dynamic.
  Do any of us feel we are done with learning? Do we have complete knowledge about anything?
- It is as much about context as content.
  Information out of context is useless. We have a lot to learn about context.
- It is not about technology – even though we argue in this study favourably for the important role played by KM technology. It is about people, values, connections and creating knowledge flows as supported by technology.
- Knowledge is the by-product of experience and interaction with others.
- Customers know more than vendors give them credit for – we have created an arbitrary boundary between us and our customers which is not helpful.
- The most valuable things we know become clear as a result of demand.
- Knowledge is personal. How important is what we know to who we are? Knowledge is a significant element in our identity.

2.7 Summary

As mentioned in chapter 1, we are experiencing a rapid changing business environment. This forces organizations to re-invent themselves in many ways, and especially to grow and to exploit the intellectual assets of the organisation. Knowledge is becoming the real differentiator for an organization to survive and be successful in the highly competitive modern economy. It is therefore vital for organizations to exploit their knowledge assets, create new ones, as well as grow an environment of knowledge awareness, continuous learning, and sharing of knowledge.

In this chapter we explored the varieties and different concepts of the term knowledge. There is a natural conversion cycle of knowledge and it needs to be “managed”.

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Aspects such as these and the many notions related to Knowledge Management is the topic set of the next chapter.

[19] Sourced from: Whitepaper of Consortium for Service Innovation

Chapter 3 Knowledge Management Perspectives and Concepts

> ***The fundamental building material of a modern corporation is knowledge. Using knowledge to make money is the real challenge***. – Valery Kanevsky, Hewlett-Packard Company
>
> ***Knowledge management is really about recognizing that regardless of what business you are in, you are competing based on the knowledge of your employees. –*** Cindy Johnson, Director of Collaboration and Knowledge Sharing at Texas Instruments
>
> ***If TI only knew what TI knows***. – Jerry Junkins, ex-CEO of Texas Instruments

3.1 Different Perspectives of Knowledge Management

Modern Knowledge management (KM) is an emerging discipline – barely 10 years old and still in an immature state – with many concepts and ideas still evolving. In many ways its elusive nature and lack of clear definition can be quite confusing for observers, practitioners, and academics. In order to better comprehend the notion of KM one may approach it from **different perspectives.** We follow here the list of perspectives suggested by Beckman (1999) and contribute by synthesizing the ideas of a number of authors as well as adding and interpreting own insights.

Beckman (1999) distinguishes between six perspectives in a thorough survey of the literature about knowledge management, namely:

1. Conceptual;
2. Process;
3. Technology;
4. Implementation;
5. Organisational; and
6. Management.

This first four sections in this chapter focus briefly on the conceptual perspective, the process perspective, technology perspective, and some practical issues that are mostly implementation related. The technology perspective is expanded later on in much more detail; it is the main topic of Part 2 of this study. We close this chapter by positioning KM in relation to the two related notions of “Information Management” and “Business Intelligence”.

In the **conceptual perspective** the following KM topics are addressed:

- Definitions of knowledge and KM;
- Principles of knowledge and KM; and
- A proposed conceptual KM Framework.

In the **process perspective** we propose a process for managing knowledge.

In the **technology perspective** we take a brief look at:

- The IT infrastructure required for KM;
- Knowledge representation;
- Knowledge acquisition;
- Knowledge repository and “Knowledge bases”; and
- Knowledge transformation.

In the **KM implementation perspective** we concentrate on:

- Certain success factors;
- Challenges; and
- KM strategies.

3.2 The Conceptual Perspective

The conceptual perspective is concerned with the definition of knowledge management, and describes a framework of knowledge management which are useful for comprehending and positioning knowledge management.

3.2.1 Definitions of Knowledge Management

Because KM is still a new area of study different authors define KM in different ways. We suggest the following two definitions as our general and working definition of KM. Both were used in practical consultation and derived from various sources; mostly from practical consulting material used in consulting engagements.

Definitions of Knowledge Management
<u>High level definition of KM</u>: Knowledge Management is the discipline of managing the processes of knowledge creation, organizing, and sharing in an organization.
<u>Working definition of KM</u>: Knowledge Management is a discipline whose objective is to systematically leverage expertise and information to improve organisational: - Efficiency (by reusing captured intellectual assets), - Responsiveness (by organising resources to respond to threats and opportunities), - Competency (by managing knowledge transfer to improve employee skills), and - Innovation (by bring people together across time and geography to share ideas).

These two definitions proofed to be useful in different occasions and formulate the essence of KM in a practical way. The working definition is particularly useful in our focus of this study as it spells out the practical and technical value of knowledge management[20].

3.2.2 Knowledge Management Principles

Principles are basic statements of intent that form an important part in strategic activities. A number of authors have proposed principles to follow while managing knowledge. After an organization agreed upon a set of KM principles, it can create detailed approaches and action plans based upon these principles. We regard the views of Davenport (1998) as well-experienced and well-accepted in the KM community. He formulated ten general principles of knowledge management – regarded as a classic in the KM field – which are summarised here:

1. Knowledge management is expensive ("but so is stupidity!").
2. Effective management of knowledge requires hybrid solutions involving both people and technology.
3. Knowledge management is highly political.
4. Knowledge management requires knowledge managers.
5. Knowledge management benefits more from maps than models, more from markets than hierarchies.
6. Sharing and using knowledge are often unnatural acts.
7. Knowledge management means improving knowledge work processes.
8. Providing access to knowledge is only the beginning of KM.
9. Knowledge management never ends.
10. Knowledge management requires a knowledge contract.

We included three lists of principles for KM from Allee (1997), O'Dell and Grayson (1998), and Tobin (2003) in the appendices for interested readers.

3.2.3 A Knowledge Management Conceptual Framework

> ***The fundamental building material of a modern corporation is knowledge. Using knowledge to make money is the real challenge***. – Valery Kanevsky, Hewlett-Packard Company

In this section we consider how we are to represent the aspects of KM and specifically utilise an existing practical framework which is meant to clarify many of the confusing viewpoints and perspectives of this field of study specifically concerning our technical focus on KM.

[20] An often found definition of KM is: "KM is getting the right knowledge to the right people at the right time so they can make the best decisions." We realise that some authors criticise this definition as impractical – notably Firestone & McElroy (2003).

Over a number of years, various authors have contributed to the challenge of clearly presenting the different aspects of KM and their mutual relationships. One of the most useful frameworks published – which the author has employed in a number of practical consulting situations on collaboration – resulted from research done by Waite & Company (1997) sponsored by Lotus Consulting. This paved the way to clearly position KM in relation to its related concepts. We briefly describe this framework in the following.

As can be seen in the series of diagrams in Figure 7 to Figure 10 the framework divides the work complexity dimension into three categories, namely: "Information Flows", "Knowledge Flows", and "Work Flows". The second dimension is the organizational complexity. This dimension is also divided into three categories, namely: "Automated Work Group", "Integrated Enterprise", and "Extended Enterprise".

As can be seen in Figure 7, the Enterprise Knowledge Management solutions category is positioned to serve the integrated enterprise (on vertical axis) in terms of knowledge flows (shown on the horizontal axis). The enterprise KM category is thus distinguished from the enterprise-wide communications category which supports the information flows. It is also distinguished from the enterprise process innovation category, which relates to work flows. Moreover, Figure 7 differentiates enterprise KM from smaller scale workgroup collaboration and from extended enterprise electronic community development. The corresponding block in Figure 8 shows that the resulting collaboration (knowledge flows) across departmental boundaries allows organizations to better leverage intellectual capital and to benefit from best practices.

Knowledge management captures information that otherwise resides in the experiences of individuals or in functional silos. KM puts it into context so that employees may use it to improve the quality of their decisions, and to systematically incorporate new learning. A "community of practice" – which we describe in detail later – is one type of knowledge management solution (Figure 9).

The illustrations in Figure 9 and Figure 10 clearly position where workgroup technologies fit as business solutions and they also indicate the positioning of the technologies for Messaging and Collaboration.

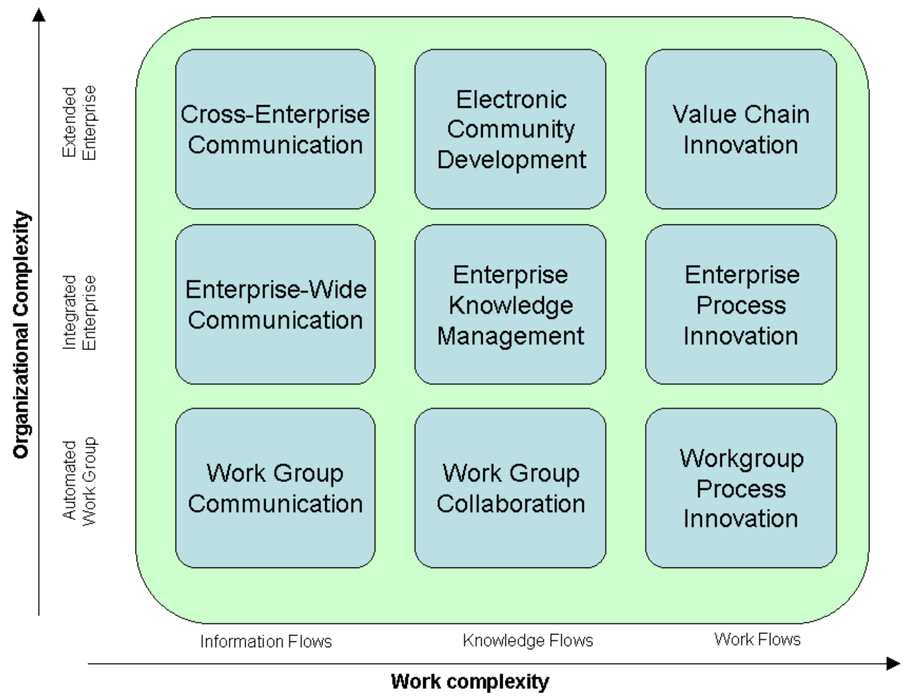

Figure 7: Lotus Solutions Framework - part 1

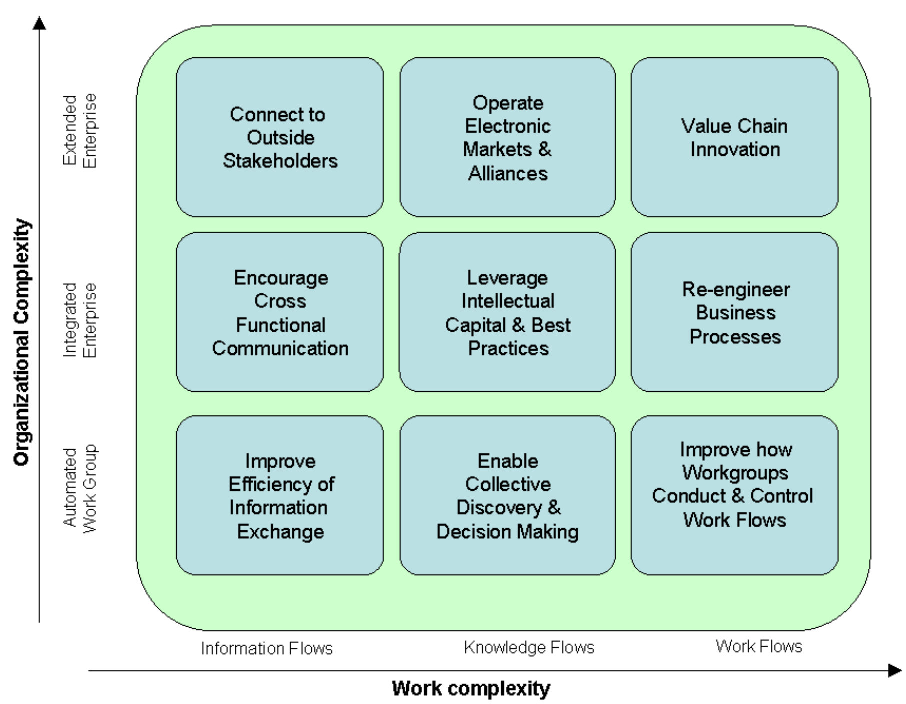

Figure 8: Lotus Solutions Framework - part 2

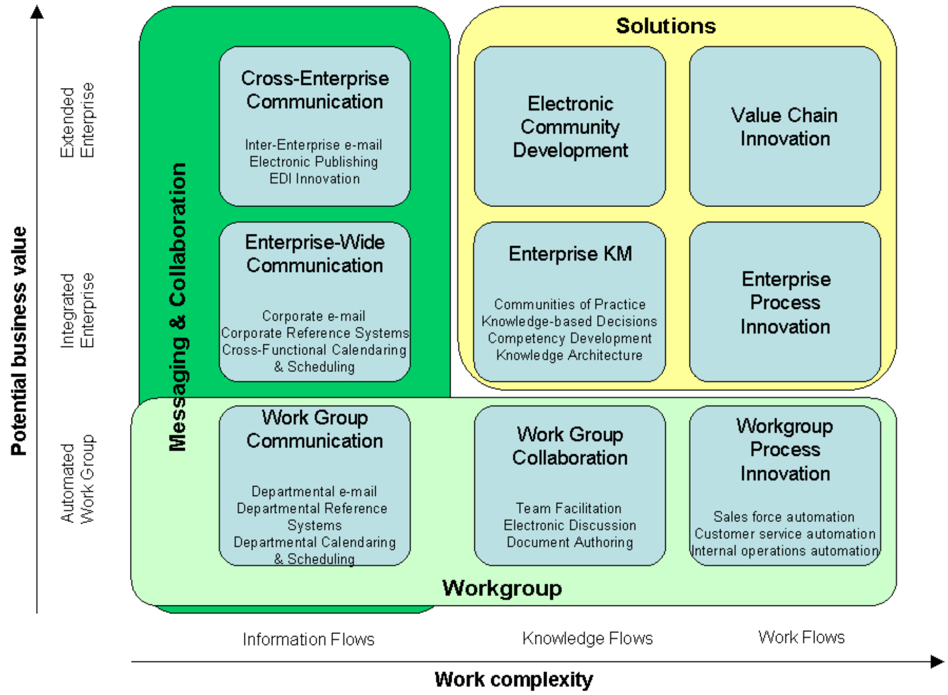

Figure 9: Lotus Solutions Framework - part 3

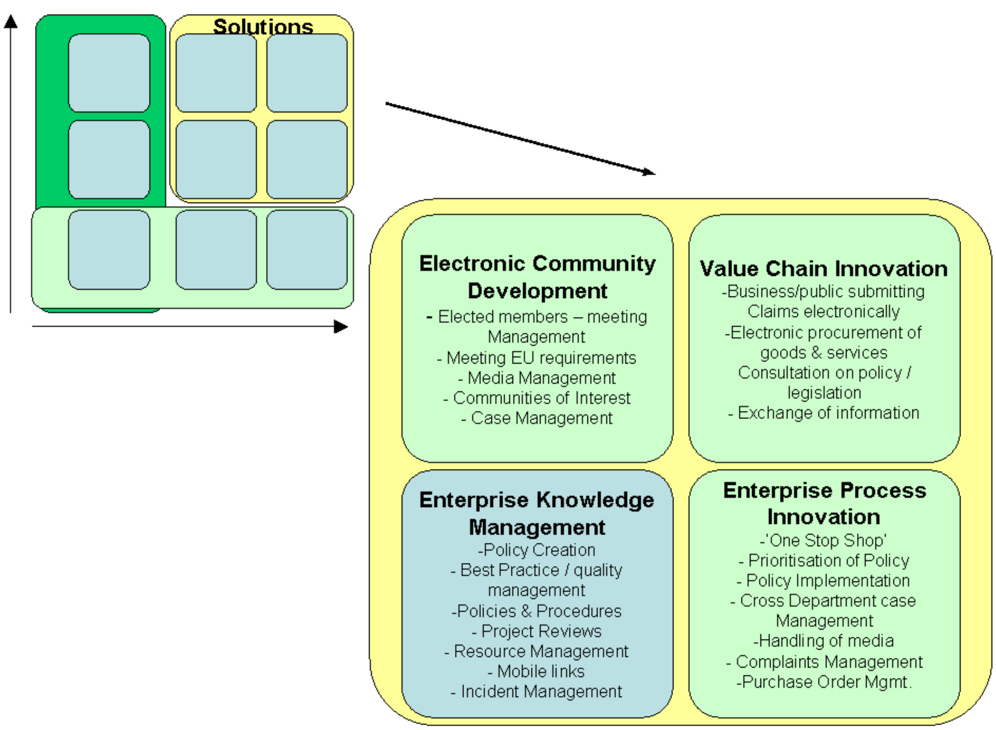

Figure 10: Lotus Solutions Framework - part 4

The third group of categories in the model, groups the set of four business solutions of the framework. In terms of the enterprise Knowledge Management solutions category important solutions are listed, namely:

- **Communities of practice** solutions enhance formal and informal knowledge sharing of best practices among people with similar work practices.
- **Knowledge-based Decisions** solutions enable the management of ongoing identification, extraction, and distribution of knowledge to workers making decisions.
- **Competency Development** solutions enable companies to leverage intellectual capital and deliver core business knowledge to individuals and groups.
- **Knowledge Architecture** solutions enable the identification, categorization, and maintenance of key business information.

As Figure 10 indicates, these solutions can be expanded into various strategic and practical activities and initiatives such as:

- Policy creation;
- Best practices or quality management;
- Policies and procedures;
- Project reviews;
- Resource management;
- Mobile links; and
- Incident management.

We will return to some of these collaboration solutions where applicable in the second part of this study.

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To date, we have defined KM, enumerated a number of key KM principles, and positioned KM in a conceptual framework.

In the next section we consider the process perspective of Knowledge Management.

3.3 The Process Perspective

Knowledge by itself is not powerful. Applied knowledge is powerful! – Anonymous[21]

3.3.1 Different Knowledge Management Processes

Before knowledge, experience, and expertise can be effectively leveraged and transformed into valuable organisational assets they must be formalised, distributed, shared, and applied. This implies that ***knowledge is managed through a process***. A number of authors have proposed ***models*** for this ***KM process***. In all of them it is assumed that steps and activities are often concurrent, sometimes repeated, and not always in linear sequence. In the following we propose our view of the business processes in which knowledge fulfils an important role.

3.3.2 Knowledge Processes

We find in businesses a number of "knowledge processes" such as Research and Development (R&D), Planning, Market Research, Customer Service, Consulting, and Decision Making. These are typical knowledge-work processes performed by knowledge workers. A number of processes are obvious components of KM such as knowledge creation, documentation, validation, and distribution[22]. Each process has a knowledge component. Some, such as R&D, concentrate on ***creating*** knowledge while some are mostly concerned with ***discovering*** knowledge such as Market Research. Some processes focus on ***organizing*** or packaging knowledge. These processes can be categorized into three processes as we discuss next.

Knowledge management, therefore, deals with knowledge processes that affect a knowledge-focused organization. There are three primary interrelated knowledge processes, each with several sub-processes:

- Knowledge creation and sensing.
- Knowledge sharing and dissemination.
- Knowledge organizing.

Knowledge usage is the result of these knowledge processes.

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[21] In other words: "It's not so important what you know, but what you do with what you know!"
[22] See Stewart (2001) for more detail.

Knowledge Creation and Sensing

Knowledge production or discovery is a process that creates new knowledge through the regrouping and combination of older concepts as well as the sensing and invention of new ones. All knowledge creation – individual, team, community, and organization – occurs through learning and is constructed from other knowledge ideas, information, data, and new insights.

When a question is asked or a hypothesis is developed, one step in knowledge production is to search for and retrieve older knowledge statements to try to prove the new hypothesis. New knowledge is created when new concepts are reformulated from older concepts. The formulation may produce a lot of knowledge or may simply bring about small improvements to current concepts that increase their explanatory and predictive power. The creation of a knowledge idea stems from a supply chain of knowledge, information, and data. For example, knowledge can be constructed through knowledge gathering from classes and formal training, experts, seminars, previous knowledge, assumptions, social networking, literature, or a combination of these.

Knowledge Sharing and Dissemination (or Transfer)

Even if vast pools of high-quality knowledge exist, the knowledge may be worthless without effective dissemination (also known as "diffusion"). Knowledge dissemination is the process by which new knowledge is communicated through certain channels over time among the members of a team or organization. This can occur in many different ways. We describe a number of ways to disseminate knowledge in Table 5[23].

Education	Education from an expert to a novice is an ancient method of knowledge dissemination. Effective transfer of knowledge is dependent on factors such as the teacher's and the student's abilities as well as the relationship between them.
Sharing	People share ideas and knowledge with other people formally of informally on a regular basis. Successful businesses focus on promoting sharing of knowledge and reward those that do.
Storytelling	This ancient technique of transmitting multiple dimensions of knowledge is recently "rediscovered" to be very beneficial for knowledge dissemination.
Writing and Publishing	The skill of writing in a way that encourages the reader while maximizing understanding is a key success factor for knowledge dissemination.
Exposing	Designing and constructing the environment to expose knowledge workers to high quality sources of knowledge, making it easy to find high quality knowledge sources and expertise when needed, should be key focus areas for knowledge dissemination.

Table 5: Ways to Disseminate Knowledge

[23] (a) Adapted from eKnowledgeCenter online course.
(b) The best knowledge dissemination takes place in Communities of Practice as we will strongly argue later …

Knowledge Organizing

Knowledge organizing presupposes that knowledge already exists and that it is beneficial to capture that knowledge. The company might, for example, want to capture the knowledge of another firm by acquiring the firm, hiring employees from that firm or by bringing in external consultants, reverse engineering some of their products, or researching the knowledge by examining published papers and articles (eKnowledgeCenter).

In Part 2 we will expand this knowledge acquisition and organizing process in detail.

3.3.3 Knowledge Management Process Model

We propose the following knowledge management process model for this study as illustrated in Figure 11.

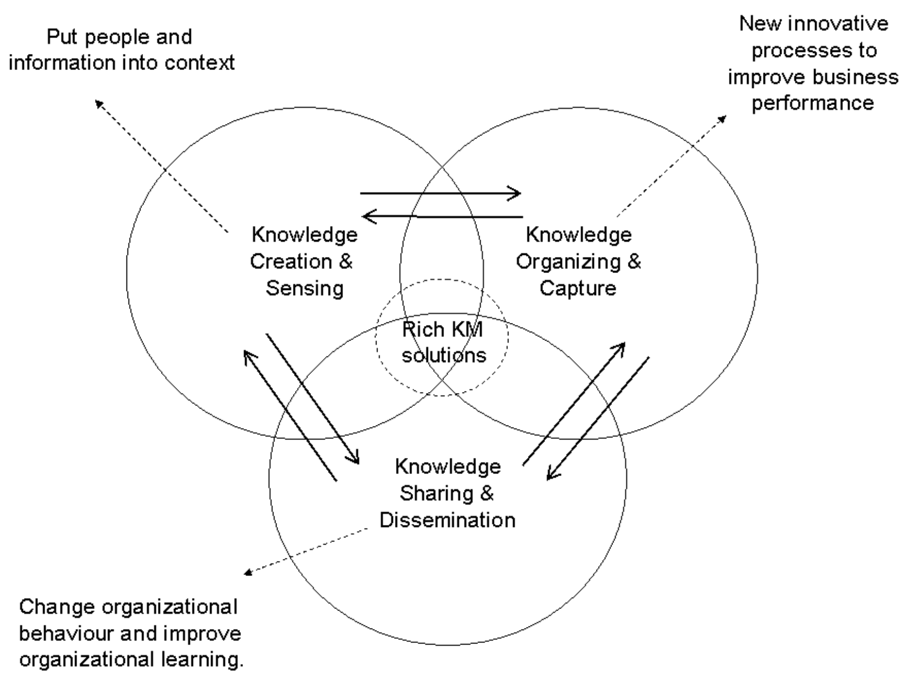

Figure 11: Knowledge Management Process Model

The KM Process Model is comprised of three knowledge processes that give rise to knowledge usage. We briefly proposed and discussed these processes in the previous subsection. They were, namely:

1. Knowledge Creation and Sensing,
2. Knowledge Sharing and Dissemination; and
3. Knowledge Organizing.

Eight key activities may be identified which take place as part of the knowledge management processes. These activities are:

1. Create and Sense — two activities that result in new knowledge or new assemblies of existing knowledge.
2. Capture — activities that record and convert tacit knowledge to explicit knowledge, i.e. that move knowledge from the individual to the team, community, and the enterprise.
3. Organize — activities that classify, map, index, and categorize knowledge for navigation, storage and retrieval.
4. Personalise – activities that internalise and make knowledge specific to individuals or communities.
5. Share and collaborate — two activities that apply knowledge to business decisions or opportunities. The "collaborate" activity is recursive; it continually generates feedback that affects and is integrated into the other processes.
6. Access — activities that disseminate knowledge to users, display knowledge (translate, format and publish), and access knowledge (browse, search, and examine).

These processes and activities are related in Figure 12. The figure additionally displays which activities are more human-focused and which are more technology-focused.

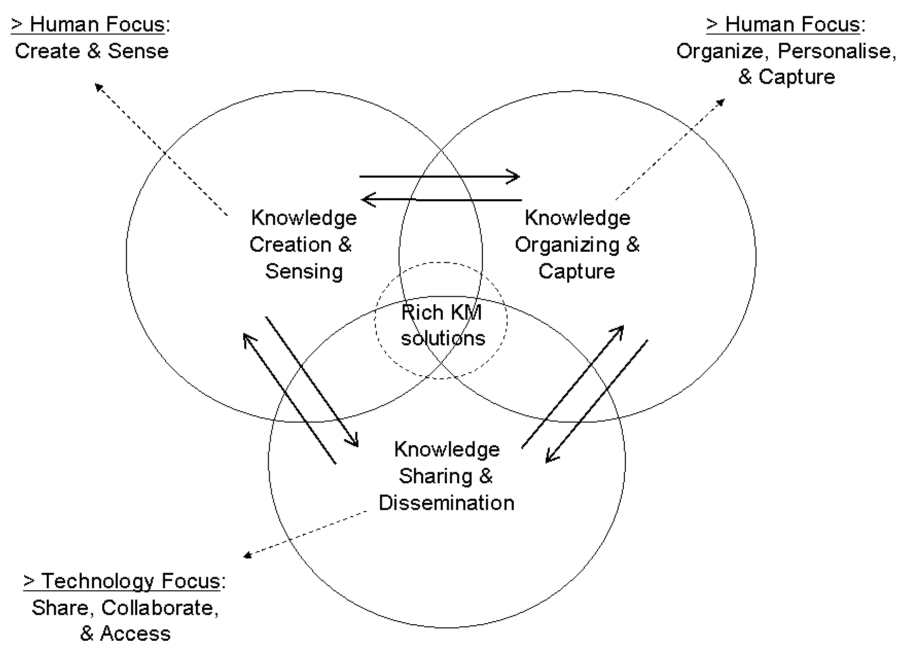

Figure 12: Knowledge Management Process Model - Activities

3.3.4 Evolution of Knowledge Management

In Figure 13 we present our view of three different KM levels that can be seen taking place as KM activities increase in an organization.

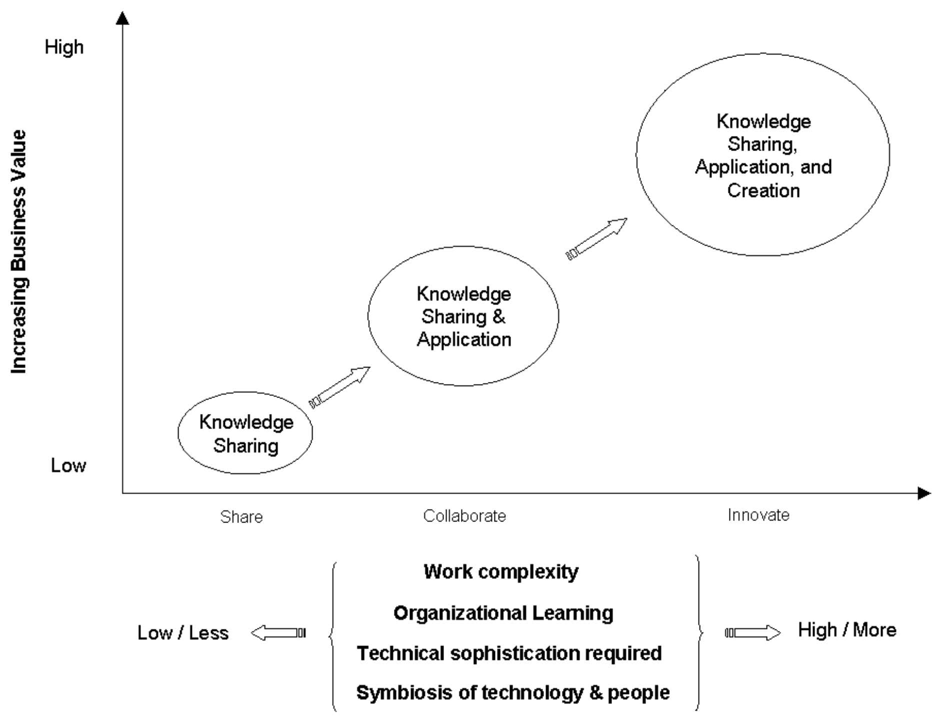

Figure 13: Three Levels of Knowledge Management

By just sharing knowledge the business value is relatively lower than when sharing is augmented by applying knowledge specifically through collaboration between knowledge workers. The highest business value is obtained when knowledge is constantly created, shared, and applied. We then expect to see a high level of innovation in the organization. The diagram of Figure 13 shows how moving from sharing to collaborating and to innovating relates to a number of key knowledge related areas of business. These include work complexity, organizational learning, the required technical sophistication to implement and maintain these knowledge areas, and the symbiosis between technology and people. Shortly after the year 2000 it seems that KM was not high on the key strategy list of organizations for a brief period. However, this clearly has recently changed as most organizations nowadays are giving attention to KM[24]. We argue here that KM is regarded today as a key strategy especially for knowledge-based organizations. We also propose that KM should be regarded as a natural evolution for modern businesses in managing the challenges of

[24] See many sources such as the respected discussion forum www.brint.com as well as industry observers such as the Gartner Group.

the business environment. KM is "built" on "layers" of previous approaches to tackle these challenges. This evolution, both in business and technology, towards KM is illustrated in Figure 14.

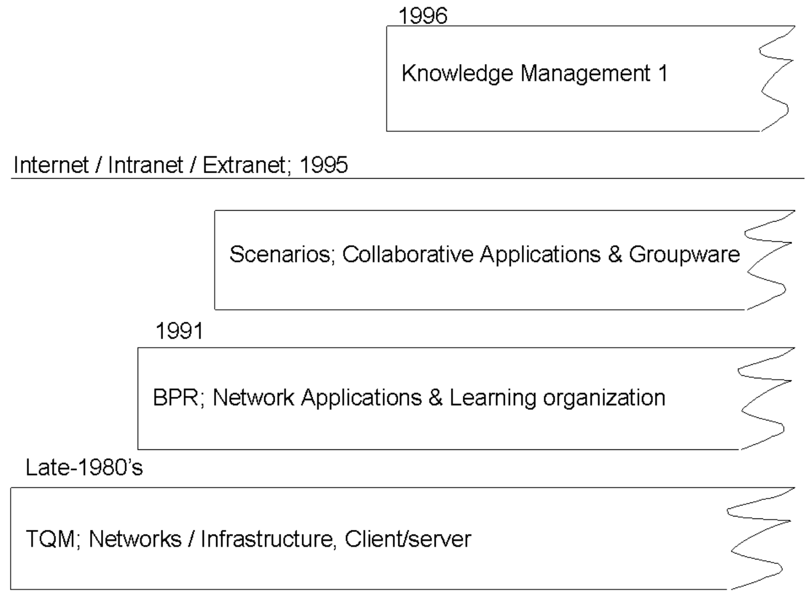

Figure 14: Evolution of Knowledge Management

The notion of KM described so far may be referred to by the term Knowledge Management 1 (KM1). In KM1 we recognise a first generation of KM. Recently some authors prefer to differentiate between two generations of KM. This view is particularly promoted by Firestone and McElroy (2003) who refer to the latest emphasis on KM as "The New Knowledge Management". The main differences between these "generations" of KM are, in brief:

First Generation KM (KM1):

- The assumption is made that knowledge already exists.
- There is primarily a ***technology focus***.
- As far as knowledge is concerned the focus is on ***knowledge integration***.
- KM1 is not strongly concerned with knowledge production.

Second generation KM (KM2):

- The assumption is made that knowledge does not necessarily exists beforehand.
- The focus is on ***knowledge production*** and ***integration***.
- Knowledge is more a human social system behaviour, driven by individual and shared processes.

Firestone and McElroy (2003) also published an extended Knowledge Management Life Cycle and described its components in depth. We take notice of this view. It is aligned with our own views about the subject although we argue that businesses should not underestimate the importance of many aspects of KM1 which laid the foundation for KM2. While progress is made with further development and research on KM, we are contributing in this study to this field by proposing models and a technology framework that are applicable to both generations of KM.

3.4 The Technology Perspective – an Overview

This section gives an overview of the technology perspective. The detail description is covered in Part 2 of this study where we propose a new view of the technology perspective. This view is related to the KM process model we have proposed in the previous section.

Many experts differ in their opinions regarding the value of IT to enable KM. See for example: (Sveiby, 2001a) and (Malhotra, 2001) as well as a number of discussion forums such as those covered in www.brint.com (regarded as the primary KM Web site). This is specifically the opinion with regard to the value of expert systems. Davenport and Prusak (2000) asserted throughout their book that knowledge management is much more than technology, but "techknowledgy" (their term) "is clearly a part of knowledge management". They also state: "***Knowledge derives from minds at work" … "Successful knowledge transfer involves neither computers nor documents but rather interactions between people***."

Nevertheless, the availability of certain technologies such as Lotus Notes and Lotus Domino, as well as the ubiquitous World Wide Web has been a major catalyst for the awareness and acceptance of the knowledge management paradigm. Beckman (1999) contributed a lot of work in support of the value of IT. He formulated and integrated the concepts of knowledge representation, knowledge repositories, and automated knowledge transformation. Other approaches found in the many sources on KM, focussed on developing software products that implement many of these concepts.[25] For example, Jackson (2001) identified six areas of technology for the KM Enterprise, namely:

- Document Management;
- Information Management;
- Searching and Indexing;
- Communications and Collaboration;
- Expert Systems; and
- Enterprise software (including vertical portals).

In Part 2 we propose our own categories of KM technology as part of our KM technology framework. This includes a category of KM technology infrastructure.

Here we summarise the topic of IT Infrastructure required for KM as background for the section on the implementation perspective.

[25] One should note that a variety of (old) technologies applicable to the knowledge management ideals have been available for quite a number of decades; for example the telephone as communication medium.

IT Infrastructure required for KM

Having an IT infrastructure in place to facilitate sharing of knowledge is a huge advantage in an organization. Knowledge and expertise can only be effectively applied if they are easily accessible, understandable, and retrievable.

An IT knowledge network will preferably include the following components:

- A knowledge base or repository – most likely a database that houses unstructured information;
- A directory of knowledge source and locality of expertise;
- A directory of learning resources; and
- Groupware for collaboration between the knowledge workers.

The IT component may include the following elements:

- IT architecture interfaces and standards;
- IT platform – hardware and software for program execution as well as storage subsystems;
- Communication – networking and security for structured data, and multi-media data such as image, voice, and video;
- Information content – structured and unstructured information;
- Software applications may include:
  - Office automation and groupware;
  - Decision support systems and executive information systems;
  - Advanced information retrieval systems/engines;
  - Intelligent systems such as expert systems, machine learning and knowledge discovery;
  - Process modelling and simulation;
  - Transaction systems such as: functional information systems including finance, marketing, HR, IS, etc.; and
- User support including help desks and electronic learning.

All of these technologies can be applied for knowledge management with strong agreement amongst experts about the value of Internet-based networking and groupware technologies for knowledge sharing.

3.5 The Implementation Perspective

The implementation perspective on KM concerns factors that facilitate success of knowledge management projects; along with those challenges that may be foreseen and avoided. Here we summarise, for completeness sake, different aspects of the following:

1. IT infrastructure implementation.
2. Critical Success Factors (CSFs).
3. Prerequisites and challenges.
4. Types of knowledge projects.

We close with some ideas about KM implementation steps.

3.5.1 IT Infrastructure Implementation

In section 3.4, the need for an IT infrastructure support of KM was emphasised. Four phases may need to be addressed in the deployment of such an IT infrastructure[26]. The order of these phases may change depending on particular business needs:

Phase 1: Establish an information systems and IT infrastructure.

Phase 2: Create knowledge repositories.

Phase 3: Develop expert system applications.

Phase 4: Develop knowledge discovery capabilities.

3.5.2 Critical Success Factors for Knowledge Project Success

A number of authors have written about Critical Success Factors (CSFs) for KM, notably the well-respected Davenport and Prusak (2000). They defined nine factors leading to knowledge project success as follows:

1. A knowledge-oriented culture - Building a positive knowledge-friendly culture is the most important factor. There are three aspects to this:
    a. Employees must have a positive orientation to knowledge
    b. There should be no factors inhibiting the sharing of knowledge
    c. The type of knowledge management project must fit the culture
2. Technical and organisational infrastructure - Employ a uniform set of technologies that are compatible with the knowledge project. Establish appropriate organisational structures, roles and skills to support the knowledge project.
3. Senior management support - Executive level support is important in implementing the changes associated with the knowledge management project.
4. A link to economics or industrial value - Knowledge management can be expensive and therefore must be justified through economic benefit or industry success.

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[26] Adapted from Beckman (1999).

5. A modicum of process orientation - Knowledge processes should be implemented to govern the knowledge management activities.
6. Clarity of vision and language - The terms and concepts used in the knowledge management program should be well defined, since terms like information, knowledge, and learning can be widely interpreted.
7. Non-trivial motivational aids - Employees need to be motivated to share and use their knowledge. However the tactics and incentives used should have a long-term impact.
8. Some level of knowledge structure - The structure of the organizational knowledge base should be redefined to reflect new learning and growth. This will make it easy for users to find the information they are looking for.
9. Multiple channels for knowledge transfer - The knowledge manager must realise that knowledge is transferred through multiple channels – online discussions, face to face contact, reports and journals, etc. – and should seek to incorporate these into the knowledge system

3.5.3 Prerequisites and Challenges

Beckman (1999) lists several challenges in implementing KM in the typical organization. We quote Beckman on four of these:

1. "First, knowledge is often hoarded, rather than shared.
2. Second, valuable knowledge developed by others is often ignored, rather than applied in daily work situations.
3. Third, knowledge and expertise are often not valued by the corporate culture, by failing to measure intellectual assets.
4. Fourth, employees who share knowledge and expertise are considered naive, rather than rewarded for their valuable organizational behaviour."

3.5.5 Types of Knowledge Projects

Davenport and Prusak (2000) found that knowledge management projects fall into ***three broad categories*** based on the objectives of the project. These are described as follows:

Knowledge Repositories.

The aim of these projects is to capture the knowledge embedded in various resources (e.g. documents, reports, journals, memos, presentations etc.) and to structure and store it in a repository for easy access and retrieval. They found three types of repositories:

External knowledge: e.g. repository of competitive intelligence gathered from trade journals, market research, analyst reports etc.

Structured internal knowledge: e.g. repository of research reports, product oriented marketing material and methods. This centres more on gathering information that is interpreted as knowledge to most users.

Informal internal knowledge: e.g. discussion database full of know-how. This gets people to articulate their tacit knowledge but not in a structured format.

Knowledge Access and Transfer.

The aim of these projects is to facilitate access to and transfer of knowledge amongst a community of users. These projects focus on finding the knowledge and transferring it to the people that need it. It is about connecting the possessors of knowledge to the prospective users – which can be a complex activity.

Knowledge Environment.

The aim of these projects is to establish an environment conducive to knowledge management. This is done through various methods: change organisational culture, behaviour and attitudes to knowledge, improve the knowledge management processes, measure and improve the value of knowledge capital.

However, Davenport and Prusak (2000) noted that in 'real' life almost all projects are a combination of these three different types but the focus may be on one aspect only or the priorities between the three aspects may change.

3.5.6 Summary: Implementation steps

KPMG recently published an insightful brochure that sketches 5 implementation steps of a successful KM implementation as shown in Figure 15. Successful implementation is done in a systematic way, building on successive "layers" of increasing knowledge rich organizational capability – away from a "knowledge-chaotic" business situation towards an ideal of a "knowledge-centric" situation. Along the way the organization becomes knowledge-aware, then knowledge-enabled and knowledge-managed. Their methodology to perform this implementation is their intellectual capital and not published. Their approach involves an assessment of the particular engagement's layer of knowledge capability followed by a deliberate series of consulting guidance and advice to guide the organization towards the ideal "knowledge-centric" capability.

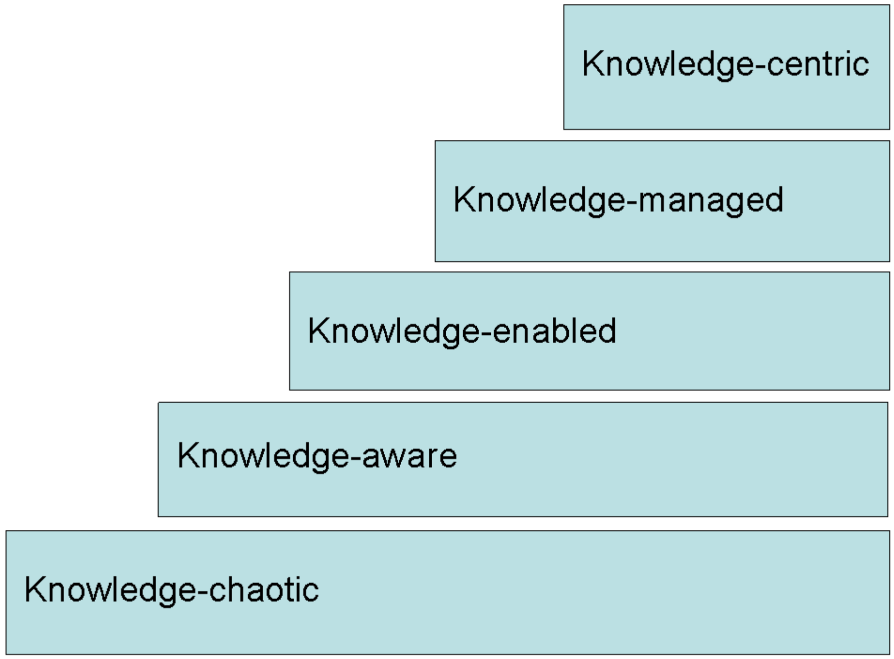

Figure 15: KPMG's Five Step Implementation Stack

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We close this chapter with a brief comparison of Knowledge Management and the notion of Information Management. We also position Business Intelligence in relation to Knowledge Management.

3.6 Positioning KM, Information Management and Business Intelligence

3.6.1 Information Management versus Knowledge Management

It is beneficial to compare main differences between Information Management and Knowledge Management in table form. Table 6: Information Management versus Knowledge Management illustrates the difference between information management and knowledge management (adapted from (McNurlin and Sprague, 2002)).

Information Management	Knowledge Management
High volume of transactions	Low volume of transactions
Low cost (value) per transaction	High value (cost) per transaction
Well-structured procedures	Ill-structured procedures
Output measures defined	Output measures less defined
Focus on process	Focus on problems and goals
Focus on efficiency	Focus on effectiveness
Handling of "data" ("pure" information)	Handling of concepts (notions)
Predominantly clerical workers	Knowledge workers: Managers and professionals
Examples: • "Back office" • Mortgage servicing • Payroll processing • Check processing	Examples: • Loan department • Asset/liability management • Planning department • Corporate banking

Table 6: Information Management versus Knowledge Management

Grey (1998) articulates these differences well when he states:

> ***"Much of what purports to be knowledge management is in reality information management. The distinction I like to make is this: working with objects (data or information) is Information Management and working with people is Knowledge Management. Information Management is about documents, CAD drawings, spreadsheets, program code. IM means ensuring access, security, delivery, and storage. It deals exclusively with explicit representations. Creation, use, learning, meaning, understanding, and negotiation are NOT core issues but efficiency, timeliness, accuracy, veracity, speed, cost, storage space and retrieval ARE central concerns in Information Management."***

3.6.2 Business Intelligence versus Knowledge Management

Business Intelligence is often seen as being synonymous or at least similar to Knowledge Management. In this study we regard Business Intelligence as an application and technology area of Knowledge Management, depending on how it is employed and used. In essence Table 7 (sourced and summarised from a number of sources) illustrates some of the vast differences between these two notions.

Business Intelligence	**Knowledge Management**
Performed by Knowledge Workers	Widespread Sharing by all
Memory of Customers	Corporate Memory
Prospects/Forecasts	Competition/Engineering
ROI Business Critical	ROI Emerging
Financial Change	Cultural Change
Analytics and Mining	Push/Pull/Filter Agents
Clustering	Categorization
Multi-Dimensional Data and Views	Knowledge Maps

Table 7: Business Intelligence versus Knowledge Management

Cody, et al (2002) argues that BI and KM may eventually be merged into a new discipline that handles data, unstructured information, and knowledge; named by them: BIKM.

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3.7 Summary

It is clear that Knowledge Management as a discipline can be viewed from different perspectives and is inherently very rich in nature and concept. This results in differentiation between different organizations dependent on how effectively knowledge is adopted strategically and exploited tactically. In this chapter we synthesised the different perspectives from many sources, thus contributing to the comprehension of this widely studied but sometimes confusing area. We specifically contributed by proposing our own KM Process Model (in section 3.3) and by putting forward our view of three different “levels” of KM sophistication.

In the next chapter we describe briefly some applicable aspects of the notion of Intellectual Capital.

Chapter 4 Intellectual Capital / Intellectual Assets

> ***Intellectual Capital is packaged useful knowledge. –*** Stewart (2001)
>
> ***Without a strategy for taking knowledge to market, knowledge management is meaningless. Selling knowledge products is one of the major business opportunities of our time. –*** Stewart (2001)
>
> ***Intellectual capital has grown so important that it, rather than ownership of physical assets, explains why companies come into being and why their boundaries fall where they do. Knowledge creation gets to the very core of what makes a firm a firm. …***
>
> ***I invent, therefore I am.*** – Stewart (2001)

In this chapter we summarise and synthesise various perspectives and considerations about the term Intellectual Capital (also known as Intellectual Assets) as far as Knowledge Management is concerned. There exists an extensive literature that covers the subject of Intellectual Capital; the most prominent are the two books of Thomas Stewart (1997, 2001). This term is often confused and misused in various contexts. One specific area of confusion is the difference between Intellectual Capital (IC) and Intellectual Property (IP) which we describe next.

4.1 Intellectual Capital is not Intellectual Property

We start by differentiating the two notions of Intellectual Property (IP) versus Intellectual Capital (IC). IP is the set of assets that include copyrights, patents, semiconductor circuit layouts rights, and various design rights. The set also includes trade marks and service marks. Auditing IP is a well-known practice but is generally not particularly useful. For example, it is rather useless to know that one owns a patent but not have the information about its commercial potential or its return on investment (ROI). IP assets are usually considered from their legal perspective. Therefore, IP and IC are considered mutually exclusive. IP may be seen as an output of IC (Bontis, 2001).

Intellectual assets are increasingly important to enterprise competitiveness and market value. Protection was traditionally afforded only to patents and copyrights; now, mission-critical business and technical processes are also regarded to be intellectual property. Key employee competencies, business data and market data are considered mission-critical intellectual capital. Competitive advantage is gained when these “knowledge assets” are enriched with employee insight and applied within the context of enterprise business principles, past experience and strategic direction.

4.2 Managing the Different Forms of Intellectual Capital

According to Stewart (2001) intellectual capital (knowledge assets) takes just two forms: First, we get the semi-permanent **body of knowledge**, the expertise and **know-how** that develops in a person, or is related to a task, or an organisation. This body of knowledge may include communications or leadership skills, understanding a particular field or industry, or being familiar with the organisation's processes, values, and culture (often articulated as: "***this is how we are doing it here***").

The second kind of knowledge assets are **tools that augment the body of knowledge**; either by making available the related facts, data, or information or by delivering expertise and contacts to other expertise when needed, in other words by leveraging available expertise. Stewart's example is: "***Phone numbers are not intellectual capital; phone books are***."

We argue in Part 2 of this study that the second form of IC mentioned here is best supported by KM technology that is specifically designed to manage IC.

Drucker (1993) describes the arrival of a new economy that he refers to as the "knowledge society". He claims that in this society, knowledge as Intellectual Capital is not just another resource alongside the traditional factors of production, namely labour, capital, and land – but the only meaningful resource today.

"***Because knowledge has become the single most important factor of production, managing intellectual assets has become the single most important task of business***," states Stewart (1997) in his much referenced book "***Intellectual Capital – The new wealth of Organizations***." Although conventional assets of organizations will persist, knowledge as an asset is gaining in importance as a product of knowledge workers and in processes that add value to work. As we progress more and more into the knowledge-based era knowledge will become inevitably a more important asset of modern day organizations – eventually becoming their most important asset.

Intellectual assets are powerful - they appreciate rather than depreciate with use. Use of intellectual assets is a necessary condition of innovation, inspiration, problem resolution, and value creation. Intellectual capital is the most important source of future value for all organizations but least understood; always being used but rarely managed.

4.3 Definition of Intellectual Capital

To answer the question: "What is intellectual capital?" we should note that organizational **knowledge assets** consist of talent, skills, know-how, know-what, and relationships (with their related infrastructure of devices and communication networks) that can be used to create wealth and survive. For this study, ***an asset is something that transforms raw material into something more valuable*** (Stewart (2001)).

Many companies today however have almost no physical assets at all. Examples include: advertising agencies as well as consulting and computer services companies which make use of a lot of information technology, and own relatively few physical assets such as desks, chairs, computer equipment, and some (even shared) conference and training facilities. Other examples are: the professional services industry and new knowledge-based companies such as Google. Stewart (1997) states:

> ***"Intelligence becomes an asset when some useful order is created out of free-floating brainpower - that is, when it is given coherent form (a mailing list, a database, an agenda for a meeting, a description of a process); when it is captured in a way that allows it to be described, shared, and exploited; and when it can be deployed to do something that could not be done if it remained scattered around like so many coins in a gutter."*** …
>
> "***Like beauty, knowledge exists in the eye of the beholder." …***
>
> ***"There's a vital lesson here: Knowledge assets, like money or equipment, exist and are worth cultivating only in the context of strategy. You cannot define and manage intellectual assets unless you know what you are trying to do with them***."

As a guideline for defining intellectual capital (IC) one can start off with the notion that ***intellectual capital is the sum of an organization's patents, processes, employees' skills, technologies, information about customers and suppliers, and (age-old) experience***[27]. These exist in the form of procedures and networking – internal and external – with business colleagues and business partners. Stewart quotes the definition of Klein and Prusak (1994) as follows:

> "***Intellectual material that has been formalized, captured, and leveraged to produce a higher-valued asset***."

Stewart adds to this a working definition of Intellectual Capital, namely:

> "***Intellectual capital is packaged useful knowledge.***"

Large global companies such as IBM[28] are inclined to define their own view of intellectual capital to reflect the unique assets of the particular organization.

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[27] Adapted from (Stewart, 2001)

[28] IBM Asset Web's definition is similar to the following: "Intellectual Capital consists of information, code, software programs, knowledge, objects, experience, wisdom and/or ideas that are structured to enable reuse to deliver value to customers and shareholders."

We use the following ***work definition*** as adapted from Stewart (2001):

Intellectual capital is the knowledge about how to transform raw material and make it more valuable.

Some of this material may be **physical.** For example, the knowledge of the formula for Coca-Cola is an intellectual asset about how to transform a (secret) mixture of sugar, water, carbon dioxide, and some flavourings into the most well-known soft drink. The raw material may also be **intangible**, such as information. For example, a lawyer takes the facts of a law case – the raw material – interprets, combines, and enhances them by using his/her knowledge of law supported by searching capabilities into similar cases – the intellectual asset – to produce an opinion or a legal brief. This is an output that is of higher value compared to the original facts by themselves (Stewart, 2001).

4.4 Intellectual Capital Domains

It has become standard to consider the organization's ***intellectual capital*** as consisting of ***three domains*****,** namely: ***human capital*** (such as its talent, skills, and expertise), ***structural capital*** (such as its intellectual property, patents, methodologies, software assets, documents, procedures), and ***relationship capital*** (its relationships with clients, market participants, and suppliers).[29] Every company possesses a unique mixture of all three of these, but depending on the industry or type of company, emphasis is placed on one of them more than the others. ***IC can be viewed as the sum of these sub-domains.*** The catering industry illustrates the point rather well (Stewart, 2001). The leading restaurant succeeds mainly because of the human capital of its chef; the franchiser relies on the structural capital of its special recipes and effective processes; while a speciality restaurant excels because of its customer capital because the waitresses has a personalised treatment of the customers and knows what their exact preferences are.

We note here the reality that when companies are compared – say in a similar industry and with very similar access to knowledge and information – the reason the one company outperforms the other is twofold:

- It is imbedded in its human, structural, and relationship capital, not in its tangible assets;[30]
- It depends largely on how this company exploits or manages these intangible assets.

In Figure 16 we illustrate this view of intellectual capital that consists of the sum of three domains, in terms of the market value of a company (adapted from (Stewart, 2001) and (Standfield, 2001)).

[29] Standfield extends Stewart's model to include/rephrase "customer capital" to "relational capital" and "social capital" (Standfield, 2001). IC is described in depth in (Stewart, 1997).
[30] This is confirmed by a number of case studies such as described in (Stewart, 2001).

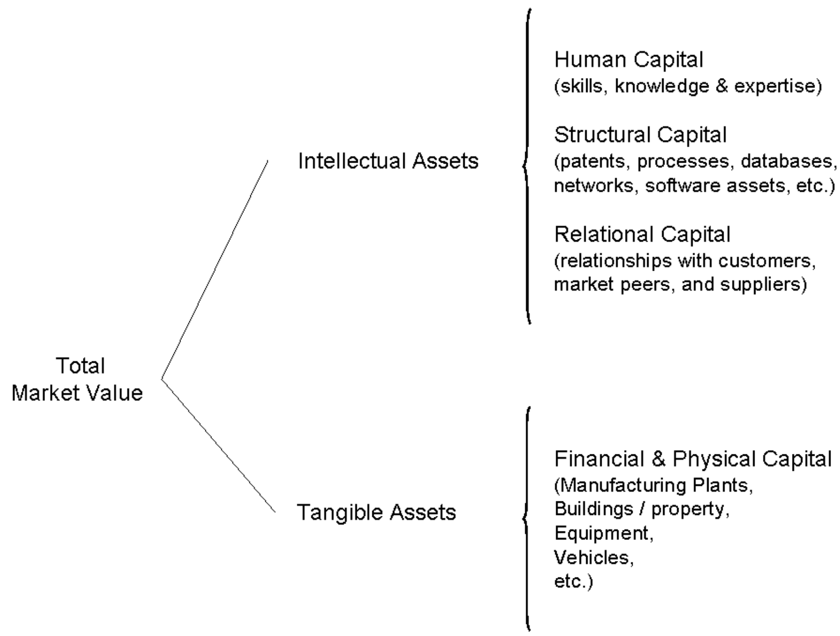

Figure 16: The Intellectual Capital Model

The Intellectual Capital Model is built upon the notion that intellectual capital resides in three strategic places in the organisation namely its people, its structures, and its external relationships (with customers and business partners) (Stewart, 1997). Thus, ***intellectual capital*** can be divided into the three domains of ***Human Capital, Structural Capital, and Relational Capital***. Each of these three domains is intangible and reflects the knowledge assets of the company – but can still be measured and managed. If divided as such it becomes possible to identify tacit as well as explicit knowledge in each of them. Tacit knowledge is mostly found in human and customer capital, in people and relationships. Most of the stock and flow of IC is tacit. Most work involves explicit and tacit knowledge in combination. "***Most knowledge management, however, limits itself to explicit knowledge; if it doesn't ignore tacit knowledge, it does a lousy job of getting at it***." (Stewart, 2001)

It is important to note that: intellectual capital is not created from discrete parts of human, structural, and relationship capital but from the **interplay** among them.

In the following we briefly describe each of these IC domains.

4.4.1 Human Capital

Human capital is made up of the capabilities of the individuals in the organization that can aid in providing solutions to customers. It is the source of innovation and renewal. It results from the competence of the individuals. For our purpose it suffices to state that **competence** is know-how plus the ability of reflection. It is the expertise of mastering the rules of the profession so well that they are obeyed as a matter of second nature.

4.4.2 Structural Capital

A collection of human capital (of smart people) on its own may not produce the flow and sharing of knowledge in the organization. Knowledge needs to be leveraged by sharing and transporting or diffusing it. This requires ***structural intellectual assets***, such as information systems, knowledge processes, competitive and market intelligence, knowledge of market channels, and management focus. Stewart (1997) articulates this need for management focus as follows:

> "***Like human capital, structural capital exists only in the context of a point of view, a strategy, a destination, a purpose***".

Structural capital packages human capital and permits it to be used again and again to create reusable value. Stewart added to this:

> "***What leaders need to do … is contain and retain knowledge, so that it becomes company property. That's structural capital. … The structural capital is more important."***
>
> ***"Even the smartest people in the world need a mechanism to assemble, package, promote, and distribute the fruits of their thinking***."

Says Drucker (1994):

> "***Only the organization can provide the basic continuity that knowledge workers need in order to be effective***."

Structural capital belongs to the organization as a whole. It can be reproduced and shared.

> "***Rapid knowledge sharing, collective knowledge growth, shortened lead times, more productive people – these are the reasons for managing structural capital***" (Stewart, 1997).

4.4.3 Relationship Capital

Relationship capital is the value of the organisation's relationships with the people with whom it does business. These relationships include customers, citizens, and market business partners including the relationships with suppliers. "***It's the depth (penetration), width (coverage) and attachment (loyalty) of our franchise" … "It's the likelihood that our customers will keep doing business with us***." (Stewart, 1997). Relationship capital is recognised in many forms such as compliant letters, renewal rates, and referrals. Relationship capital is based in learning, in access, and in trust.

We illustrate the positioning of the three domains of IC in Figure 17 and show the relative difficulty in developing and managing these three domains[31].

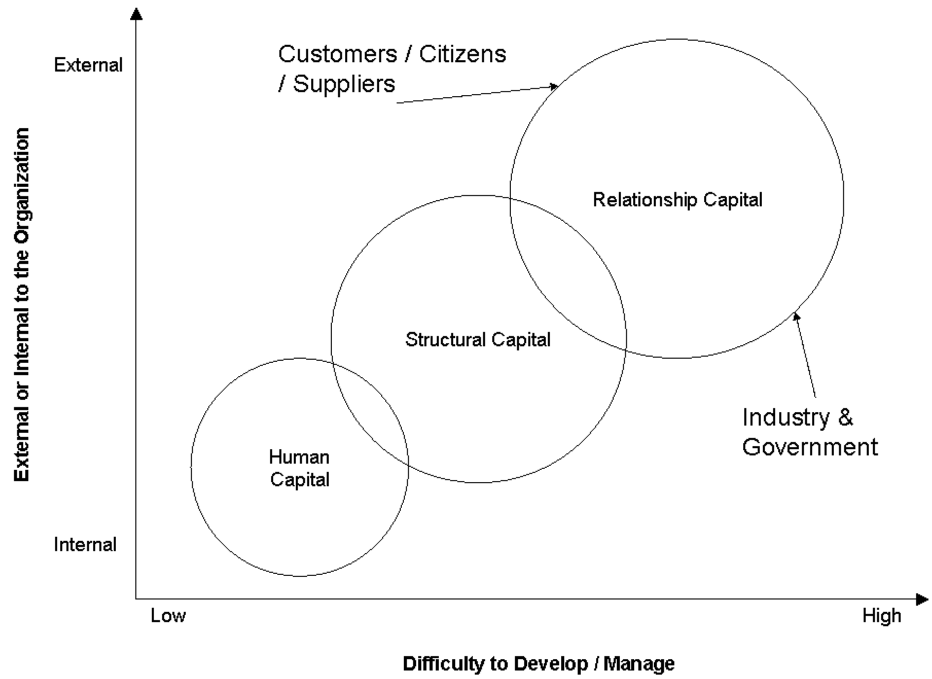

Figure 17: Positioning the Three Domains of Intellectual Capital

4.5 Closure and Summary

Corporations are projecting their knowledge products and themselves in a paradigm that focuses on knowledge and KM. Examples are[32]:

- The Swedish manufacturer of electrical machinery, ABB, refers to itself as "***We build knowledge.***"
- Fortune magazine claims that the magazine "***replaces what the martinis destroyed***."
- Ford says "***Ride New Ideas***."
- Eli Lilly reminds "***Knowledge is powerful medicine***."
- IBM's famous idea is "***THINK***" and they name their laptop a ThinkPad.

Increasingly the IT industry is moving into selling knowledge. Products and services such as configuration, systems integration and consolidation, consulting, network design, etc. A sizable portion of IBM's revenue stems from licensing and rights to its huge base of patents and other intellectual capital.

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[31] Adapted from (Bontis, 2001).
[32] Adapted from Stewart (2001).

We summarize this chapter by combining the different Intellectual Capital domains into Table 8 in terms of their essence, scope, parameter, and codification difficulty (as adapted from Bontis (2001)).

	Intellectual Capital		
Domain	**Human**	**Structural**	**Relationship**
Essence	Intellect	Routines	Relationships
Scope	Internal within employee	Internal organizational links	External organizational
Parameters	Volume	Efficiency	Longevity, durability
Codification Difficulty	High	Medium	Highest

Table 8: Comparison of the Three Domains of Intellectual Capital

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In the next chapter we take a closer view at organizational learning and the notion of the learning organization.

Chapter 5 Organizational Learning and the Learning Organization

Stick close to your desks and never go to sea
And you all may be rulers of the Queen's Navee! – W. S. Gilbert[33]

5.1 Introduction

We begin by quoting from the executive summary of the well-known business management consultant Peter Drucker (1988) (our emphasis):

> ***"Twenty years from now, the typical business will have half the levels of management and one-third the managers of its counterpart today. Work will be done by specialists brought together in tasks forces that cut across traditional departments. Coordination and control will depend largely on employees' willingness to discipline themselves.***
>
> ***Behind these changes lies information technology. Computers communicate faster and better than layers of middle management. They also demand knowledgeable users who can transform their data into information.***
>
> ***Information-based organizations pose their own special management problems as well: motivating and rewarding specialists; creating a vision that can unify an organization of specialists; devising a management structure that works with task forces; and ensuring the supply, preparation, and testing of top management people. Solving these problems is the management challenge for the rest of the century."***

Drucker's view were prophetic words as during the 1990's we saw dramatic trends in flatter organizations[34] and increased use of outside (knowledgeable) consultants. We quote from his article to emphasise some of Drucker's insights, such as:

> ***"The typical business will be knowledge-based, an organization composed largely of specialists who direct and discipline their own performance through organized feedback from colleagues, customers, and headquarters. For this reason, it will be what I call an information-based organization.***
>
> ***But as soon as a company takes the first tentative steps from data to information, its decision processes, management structure, and even the way its work gets done, begin to be transformed. ... Information is data endowed with relevance and purpose. Converting data into information thus requires knowledge. And knowledge, by definition, is***

[33] The power of knowledge!

[34] See the NBER report: Rajan and Wulf (2003).

specialized. (In fact, truly knowledgeable people tend toward over-specialization, whatever their field, precisely because there is always so much more to know.)

The information-based organization requires far more specialists overall than the command-and-control companies we are accustomed to … In its central management, the information-based organization needs few, if any, specialists … So the organization that will be developed will go beyond the matrix and may indeed be quite different form it. One thing is clear, though: it will require greater self-discipline and even greater emphasis on individual responsibility for relationships and for communications … The other requirement of an information-based organization is that everyone takes information responsibility."

Drucker describes **three major revolutions** in the concept and structure of organizations. **The first revolution** took place between 1895 and 1905. It distinguished management from ownership. It established **management as a work and a task** in its own right.

The second revolution took place in the early 1920s. This was the development of the modern organization. This introduced the modern organization of today – the **command-and-control organization**. The emphasis is on decentralization with departments and divisions, central service staff, personnel management, the whole system of budgets and controls, and the important distinction between policy and operations.

The third revolution is taking place now: the shift from the command-and-control organization to the **information-based organization**, the organization of knowledge specialists. The existence of this third revolution and how it related to KM is supported by authors such as: Toffler and Toffler (1995), Tapscott (1996), Grulke (2000), Stewart (2001), Malhotra (2001, 2004), Ponzi and Koenig (2002), Koenig (2004, 2005).

5.1.1 Stakeholders not just Shareholders

One of the major implications of the modern business environment is the recent demand on modern businesses to expand their focus and **not only** concentrate on **adding value for** their **shareholders**. It became critical for organizations to focus instead beyond the shareholders on the broader group of their **stakeholders**[35]. This is explained well by Visser and Sunter (2002) in their book "***Beyond Reasonable Greed: Why Sustainable Business is a Much Better Idea***". Organizations are expected to satisfy the needs of their shareholders, employees, and business partners while fulfilling modern obligations such as their legal, social and environmental responsibilities. These modern demands place more emphasis on how organizations perceive their societal roles and how the expertise within the organization is forced to become very diverse and

[35] Stakeholders include: shareholders, employees, customers/citizens, business partners, suppliers, as well as social, environmental and government responsibilities.

needs to expand continuously in alignment with its stakeholder demands. The typical organization needs to become ever more agile to respond to the rapid changing environment and should develop and retain vastly increasing knowledge-based capabilities in order to survive.

The result of these observations about the demands on the modern organization is that organizations should adapt over time by concentrating on ***continuous learning*** of their people – knowledge workers as well as other employees. This should happen with a much more concentrated focus on on-the-job learning in addition to formal class-based and instructed education and training. Each person of the organization as well as each person closely involved as an external business partner – is obliged to continuously learn in a focussed way in order to grow.

5.1.2 Transforming the Way to Learn

According to Davis and Botkin (1995) the existence of the knowledge business is transforming the way we learn. The knowledge business is mastering the opportunity presented by the knowledge revolution in significant ways some of which we list and quote as follows:

1. Business is coming to bear the major responsibility for the kind of education that is necessary for any country to remain competitive in the new economy.
2. The market place for learning is being redefined dramatically to lifelong learning, whose major segments are customers, employees, and students.
3. Any business can become a knowledge business by putting data and information to productive use, creating knowledge-based products and services that make its customers smarter.
4. A new generation of smart and humanized technologies may revolutionize learning by employees and customers in business before it affects students and teachers in schools.
5. Business-driven learning will be organized according to the values of today's information age: service, productivity, customization, networking, and the need to be fast, flexible, and global.

We consider these points of view as important because we realise that the **key point** to be made today is:

> Businesses should not focus only on knowledge per se or even on KM. In the new millennium a prime focus area for success is about individual learning and specifically about **organizational learning**.

In order to address the challenge of organizational learning, we next describe our own view of the nature of the modern knowledge-based organization and focus thereafter on organizational learning.

5.2 The Knowledge-based Organization

Seen in a mechanistic way an organization is an example of an open system that processes business input and produces business output. But, from a more knowledge-focussed view, an organization consists of **three domains**, namely: People with their knowledge & skills, Business processes, and supporting Technology as illustrated in Figure 18.

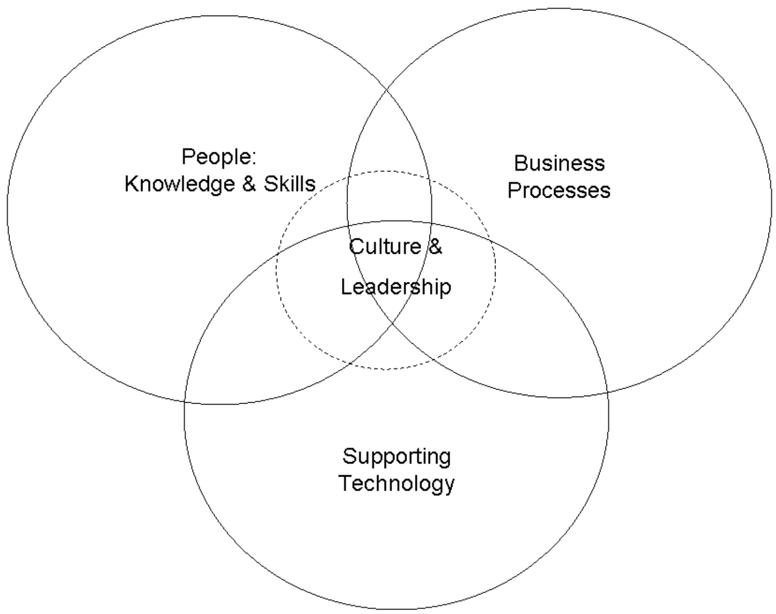

Figure 18: An Organization's Three Domains

The organization has a life of its own because it consists of individual human beings, their structures, and co-operation, how they behave, their culture, their external image, their morale, and leadership, as well as how they organise themselves through processes, and how they are supported by technology. An organization is thus far more than a mechanistic robot-like information processing engine. Knowledge of knowledge workers and their dynamics, along with the way in which ever evolving technology is exploited and employed for business support, make businesses much more like living organisms that learn and grow in order to survive and prosper. It is in essence a complex and adaptive (a learning) system that needs to react to external opportunities and threats in order to grow and survive.

In the following sections we develop and describe models and aspects that are typical of those organizations that are exploiting knowledge and in doing so become knowledge-based. We cover the aspects of the knowledge worker, a model for the knowledge-based organization as well as its characteristics applicable to this study.

5.2.1 The Age of the Knowledge Worker

In this section we take a look at the knowledge worker who plays an important role in knowledge management.

A traditional company is largely a collection of physical assets, owned by its owners who are responsible for maintaining them, and who appoint people to operate these assets. In contrast a knowledge company differs from this model in many ways, because not only are the key assets intangible, but it is also neither clear who owns them nor who is responsible for maintaining them. As described in chapter 4 above where we cover Intellectual Capital, the typical knowledge-based organization may own only a few traditional assets. As Stewart (1997, 2001) points out: "***The knowledge company doesn't care about owning capital. In fact, the fewer assets the better; so long as it has intellectual capital***". Stewart also quotes Strassman[36], author of the book "***The Business Value of Computers***", who calculated the annual cost of equity capital for 3,000 US companies compared to their information expenses. More than 90% of the companies spent more for information. The median company paid nearly five times more.

More and more people spend their working life involved with information, ideas, and knowledge. The following table illustrates the major transformation in organizational make-up as the information era is progressing (quoted in (Stewart, 1997) from the US National Bureau of Standards).

Year	Production Workers	Personal Service	Managerial & Administrative	Technical & Professional
1900	73.4%	9.0%	13.3%	4.3%
1940	57.2%	11.7%	23.6%	7.5%
1980	34.2%	13.3%	36.1%	16.1%

One can conclude that an ever-growing part of all workers today are "knowledge workers". Stewart (1997) maintains that knowledge-intensive companies – those that have 40% or more knowledge workers – accounted for 28% of total US employment in the late 1990s, but produced 43% of new employment growth. What should also by noted, is that on top of an increase in people doing knowledge work the knowledge content of all work is also increasing – including work in agriculture, blue collar work, clerical, and professional.

The increasing percentage of knowledge workers has fundamentally changed the nature of work including that of managers. Managerial work used to be described by the acronym POEM,

[36] See Website: www.strassman.com.

standing for Plan, Organize, Execute, and Measure; a characteristic of industrial Taylorism.[37] Knowledge work is vastly different from industrial era work. It is mostly professional in nature. Professionals are measured not by the tasks they perform but by the results they deliver. The professional interacts with peer experts and less with the managerial hierarchy than the industrial worker to complete tasks and projects. When work is about knowledge the professional work model is followed rather than the bureaucratic model. This resulted in "flatter" organizations and new managerial methods. Mass production industrial work required command-and-control management with the "boss" knowing more than the employee. Knowledge workers are most likely employed because they know things their "bosses" don't. Knowledge workers working alone or in teams plan, organize, and execute many aspects of their own work; while some of worker measurement is done by computer. This has resulted in less of a need for middle management and has therefore resulted in generally "flatter" organization structures. The requirement for management in the information era is firmly on "leadership" as opposed to management. The most valuable parts of the knowledge-based work involve pure human capabilities such as sensing, judging, creating, collaboration, and relationship building.

Additionally the typical knowledge worker is experiencing a largely undefined working environment with a multitude of ill-defined outcomes. On top of this the knowledge worker is experiencing a number of role changes during a typical working day. For example: he/she can act in one meeting as a project manager, then be a subject matter expert (SME) in the next meeting, and a while later changes roles again by responding to a request for input to a remote group or team. This same knowledge worker may be involved in a separate Community of Practice in his/hers semi-private time after working hours.

5.2.2 An Enterprise Model

A number of authors have described models of the organization. For example, we have already noted the model described by Sveiby (2001b) who specifically approached this topic from a managerial and knowledge-based perspective. We propose here, however, our own Enterprise Model of the modern knowledge-based organization. This consists of various strategic, tactical, and operational business models employed within and by the organization. Our enterprise model is illustrated in Figure 19.[38] This model describes the complexity of the modern business environment and how organizations organise themselves to operate and grow in such an environment.

The main purpose of the modern business is to produce products or deliver services required from its customers in co-operation with its strategic business partners through its different Relationship

[37] After Frederick Winslow Taylor, the industrial engineer who founded Scientific Management at the turn of the 19^{th} century into the 20^{th} century. His contribution was the value of managerial brainpower or "Father Knows Best" management. (Stewart, 1997)

[38] Adapted and expanded from a number of sources but is basically a new contribution in this context!

Models. We emphasize two specific Relationship Models, namely the Customer Relationship Model (CRM) and the Supply Chain Model (SCM). These models are built based on the organizational knowledge about the particulars and specific needs of the customers. The models also add value by exploring relationships and co-operation with strategic business partners and suppliers.

The modern-day organization utilises its Go-to Market Business Model to effectively use the business environment to serve its customers while defending itself against its competitors or new entrants into its market via its Competitor Model. The typical e-business model of operation relies on co-operation with its strategic business partners and suppliers while adding value for its customers, in many instances acting more-and-more as a virtual enterprise. Its Core Business Model is therefore designed to link the demand side and the supply side of the business. The model also shows the demands on organizations for acting as responsible citizens with social responsibility as well as paying attention to environmental and legal issues and responsibilities. A key part of this model – that forms the backbone of the organization and enhances its ability to survive – is the existence of leadership and a business culture that emphasises organizational knowledge and organizational learning, while placing value on Intellectual Capital. (See also in this regard: Figure 18 on page 66.)

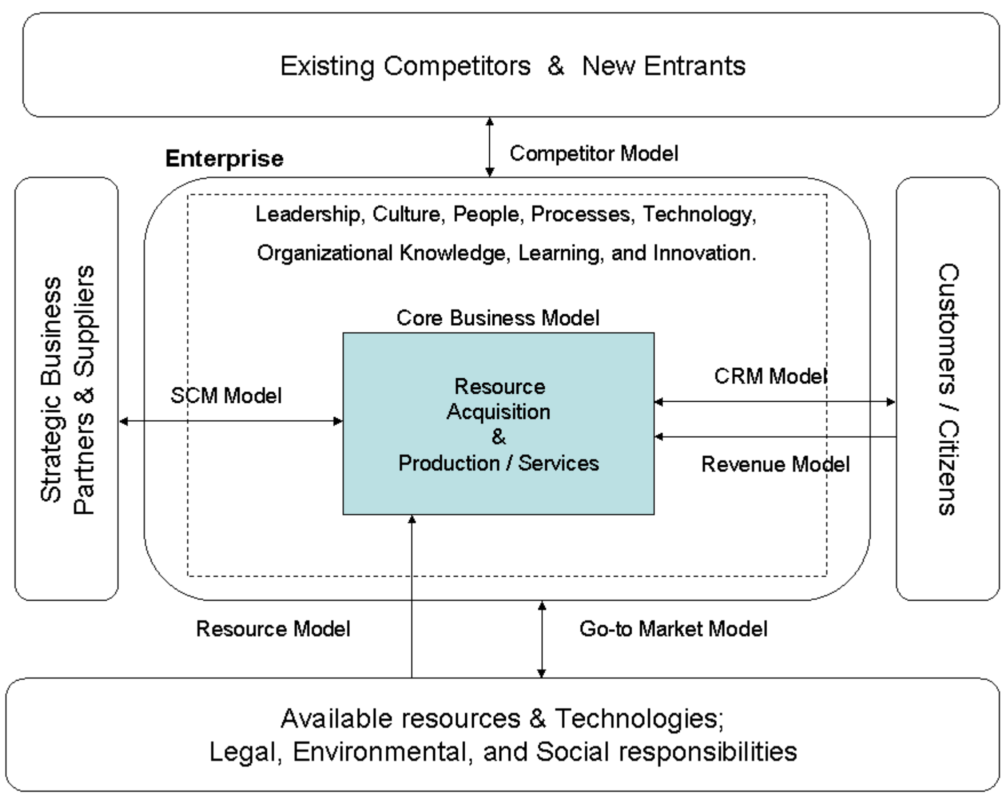

Figure 19: Enterprise Model

5.2.3 The Characteristics of the Knowledge Organization

In summary, we list here a number of characteristics that can be used to differentiate the Knowledge Organization from other contemporary organizations.

The Knowledge Organization:

- Is customer-driven, improvement-driven, and excellence-driven.
- Is highly flexible and can adapt when required.
- Has high levels of expertise and knowledge.
- Has high rates of organizational learning and innovation.
- Is innovative and IT-enabled.
- Is self-directed and managed – employing leaders rather than managers.
- Has a culture of being proactive and futuristic.
- Values expertise and sharing of knowledge.

The knowledge organization is continuously learning in order to survive and grow. We address the matter of successful learning by an organization in the next section.

5.2.4 Successful Enterprise Learning

The successful enterprise uses its knowledge assets to learn from that which has been sensed in its business environment, and by innovating new products, services, channels and processes. It then transforms itself rapidly by its innovations and excels in exploiting opportunities and overcoming challenges. This enterprise is enabled by information, knowledge and technology. It wins because of its knowledge of customers, products, internal and cross-organization processes, and the business environment. This is illustrated in Figure 20.[39]

This diagram draws attention to the complexity of the business environment and indicates how the successful organization responds to the many and diverse parameters. External parameters in the left hand side of the diagram include many related financial events and trends, legal obligations, the dynamics of internal and value-chain processes, as well as different environmental and other business issues. On discovering or sensing these parameters the organization responds by accumulating or updating this new or changed knowledge and in doing so continues to learn as an organization. This learning – as we will discuss in detail in the following sections – includes acting on the new knowledge and reflecting on the implications imposed on the organization and its business. The cycle indicated in the diagram of Figure 20 leads to processes of innovation to counter the effects of, or take advantage of the new knowledge acquired. The result of this innovation affects internal parameters listed on the right hand side of the diagram and usually leads to a transformation in the way the organization does business.

[39] Adapted from a number of sources.

In this diagram we combine a number of ideas about the successful enterprise by emphasizing the role played by the organizational knowledge and the organizational learning. We also illustrate the continuous cycle that the modern knowledge-based organization has to exercise in the current dynamic and complex business environment. The key point, however, remains the core and prime position taken by the organizational knowledge and its management.

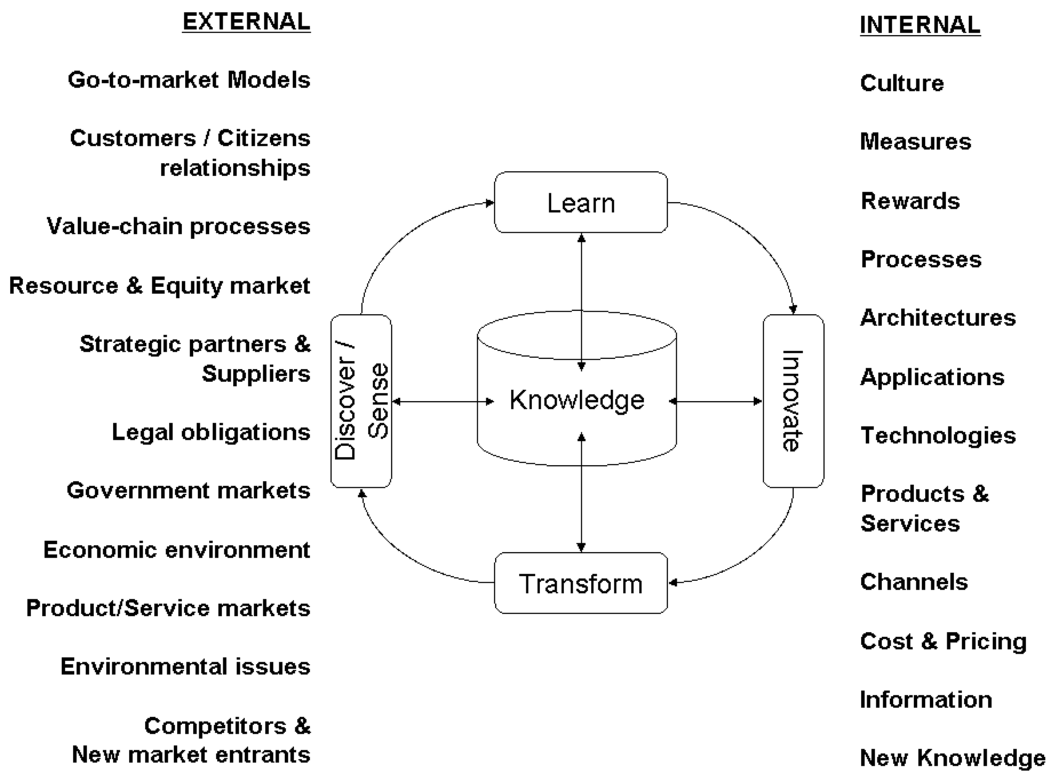

Figure 20: Successful Enterprise Learning

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In the next section we explore this important KM aspect, namely organizational learning.

5.3 Organizational Learning

A firm is nothing else but what it knows, how it harnesses and co-ordinates what it knows, and how fast it can know something new. – Laurence Prusak

Learning can only be done in two ways: Either one learns from the expertise of others who know or by trial-and- error. It's much more beneficial to learn from others as children do.
– Age old wisdom (adapted)

Why is there always time to do it over, but never time to do it right first? - Anonymous

An organization's ability to learn, and translate that learning into action rapidly, is the ultimate competitive business advantage. – Jack Welch, chairman of General Electric

In this section we explore the important knowledge management aspect of organizational learning. KM and its learning aspect, as discussed so far, logically imply that an organization has to employ and grow its intellectual capital and knowledge assets. In doing so the organization needs to embark on an organizational learning programme. We briefly discuss here the following topics: organizational knowledge, what is a learning organization, and conclude with some applicable remarks about the knowledge-enabled organization.

5.3.1 Organisational Knowledge

We pointed out in Figure 5, that organizational knowledge consists of five different types of knowledge, namely: know-what, know-why, know-how, know-who, and know-when. Our view is that the organizational knowledge is constituted by the collection of knowledge of individual knowledge workers who share their knowledge while interacting with other employees. We can derive two key characteristics of organizational knowledge from this. Firstly, organizational knowledge is knowledge that is shared among organizational members. We particularly note a number of views of authors indicating that although organizational knowledge is created via individual knowledge, one may regard organizational learning – which is closely related to organizational knowledge – as another case of the "whole being bigger than the sum of the parts". Secondly, organizational knowledge is distributed – being created and managed by individuals who act autonomously within a decision domain.

These two characteristics are conflicting, which increases the difficulty of managing organizational knowledge. Therefore, it is required to construct a powerful, intelligent information infrastructure to support KM. We already described one such construct for an infrastructure when we described the Knowledge Creation Life Cycle of Nonaka and Takeuchi (1995) in Table 4. In Part 2 of this study we will expand this concept, introduce other alternatives, and describe the detail of this infrastructure.

The concept of collective learning is investigated in various fields of study but is still not well understood. We will touch in the following on some of the issues that these studies have addressed where applicable to our particular focus. Therefore, in this section we summarise and synthesise various perspectives and considerations related to organisational learning. In the next section we take a closer look at the concept of a learning organization.

5.3.2 What is a Learning Organisation?

According to Garvin (1993), "***A learning organisation is an organisation skilled at creating, acquiring, and transferring knowledge, and at modifying its behaviour to reflect new knowledge and insights."*** These organizations must continually refresh and update their intellectual capital (IC). This is the process of organizational learning. The intellectual capital grows as individuals interact with each other in order for the organization to react to changes and demands of its external environment. According to Bontis (2001), "***It may be useful to consider IC as the stock unit of organizational learning***." However, IC cannot necessarily be taught through education and training. The most precious knowledge in an organization often cannot be passed on.

We can distinguish between individual, group, and organizational knowledge creation. All knowledge creation occurs through learning. When an individual learns,[40] he/she creates personal knowledge even though that knowledge might not be new to other individuals. Collective knowledge creation is when a set of rules believed to be true – called a knowledge claim – is either submitted to the group by an individual or the group co-creates the knowledge claim through collaboration. In this sense, a group learns. The group's knowledge claim might or might not be new to other groups within an organization. If it is new, and a substantial number of peer groups believe the knowledge claim to be true, then the knowledge claim becomes organizational knowledge, and thus the organization learns.

Therefore, the creation of new knowledge is the point at which individual and organizational learning come together. Essentially then: in the modern organization the act of **working** and that of **learning** are the same.[41]

The way that learning is connected to working takes place in the learning spiral of conceive, act, and reflect as illustrated in Figure 21.[42]

These activities – we will argue in Part 2 of this study – can be supported by technology such as groupware and so-called knowledge portals.

[40] Actually: Organizations do not learn – individuals learn!
[41] Already previously hinted at in Coleman (1997) and Tapscott (1996). Especially in the present day knowledge-based society the life style should be "life-long learning".
[42] For interest sake and out of scope of the study: The activity of "reflection" is very much underrated in the Western world compared to corporations in Japan.

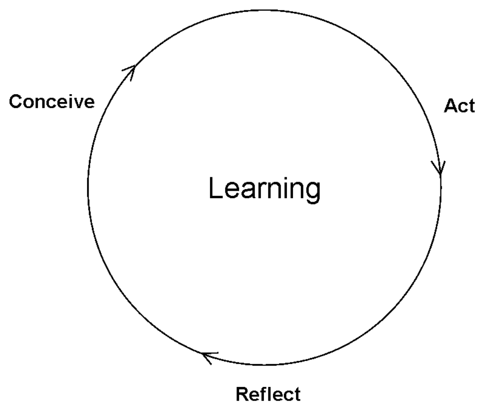

Figure 21: Learning Spiral

We should point out here, that the organization cannot create knowledge without individuals. It is, therefore, important for the organization to provide the context and to support and stimulate the activities for creating knowledge. Organizations therefore have to change their thinking about learning. Learning or knowledge creation takes place at three levels: the individual, the team, and the organization. This is illustrated in Figure 22.

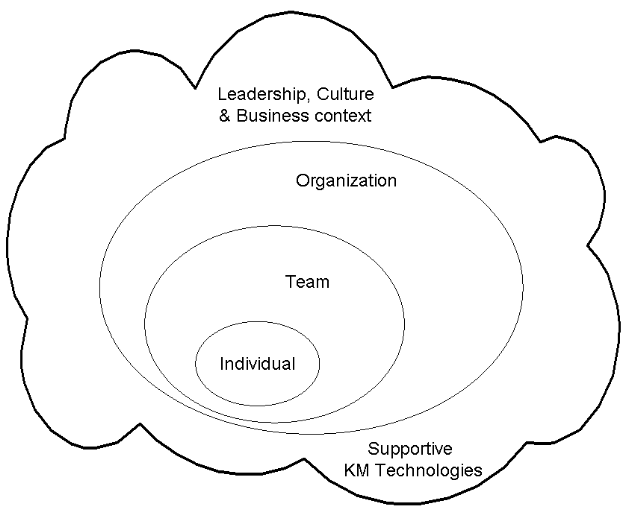

Figure 22: Individuals Learn in the Context of the Organization

Three critical issues must be addressed before a company can truly become a learning organization, writes Harvard Business School professor David Garvin (1993).

- First, is the question of meaning: a well-grounded, easy-to-apply definition of a learning organization;
- Second, comes management: clearer operational guidelines for practice; and
- Finally, better tools for measurement can assess an organization's rate and level of learning.

Garvin states that learning organizations are skilled at five main activities, namely:

- Systematic problem solving.
- Experimentation with new approaches.
- Learning from own experiences and past history.
- Learning from the experiences of others (even doing SIS – "Steal Ideas Shamelessly").
- Transferring knowledge quickly and efficiently throughout the organization.

And, since one cannot manage something if it cannot be measured, a complete learning audit is a must. That includes measuring cognitive and behavioural changes as well as tangible improvements in results. Garvin finally warns that learning organizations are not built overnight but are the result of carefully cultivated attitudes, commitments, and management processes. He lists a few major steps required to become a learning organization.

- The first step is to foster an environment that is conducive to learning (including time for reflection and careful analysis). Training in brainstorming, problem solving, etc. is therefore essential.
- Secondly, open up boundaries and stimulate the exchange of ideas.
- Thirdly, once a more supportive open environment is established, management can create learning forums; invite strategic reviews; etc.

He argues forcefully that the learning organization should make a subtle shift in focus, away from continuous improvement and toward a commitment to learning.

5.3.3 From Organisational Learning to the Knowledge-enabled Organization

> ***When I started my job at (the newspaper) Svenska Dagbladet I was taught that it was a Publishing Company. A few years and a dozen management books later I was working in an Information Company. Now I am employed by a Know-How Company. A career without even having to change employer! I sometimes wonder whether the development only has happened in the heads of some authors.*** – Journalist in Scandinavia in 1989 about the Know-How Company (quoted by K-E Sveiby (1994))

Because of its applicability to this study, we give a brief summary of the well-researched subject: the knowledge-enabled organization. (See for example references such as Senge (1990), Kim (1993), Tobin (1998), and Andreu and Sieber (2001).)

Organisational learning, as we discussed before, can only take place through the collective learning of individuals who then share their insights and experiences across the organisation to enable the organization to change and enhance its response to environmental stimuli. Kim (1993) develops this in his model of organisational learning. In this model, individuals improve their mental models, which are their internal images, values, norms, and principles of how the business world works; through an experiential learning cycle that Kim has termed observe-access-design-implement. These mental models are shared and made explicit to become shared mental models. Through sharing, actively interacting, and experimenting the mental models are further refined and improved. Over time the shared mental models are incorporated into the organisation. This change in behaviour related to the new shared mental model is what we associate with organisational learning.

The knowledge-enabled organization is therefore the result of a progression through an organizational learning process. As illustrated in Figure 23, a process has to be completed whereby mental models are developed for creation of individual and organizational tacit knowledge and the sharing of the individual tacit and explicit knowledge to create tacit and explicit knowledge within teams, communities, and the whole organization.

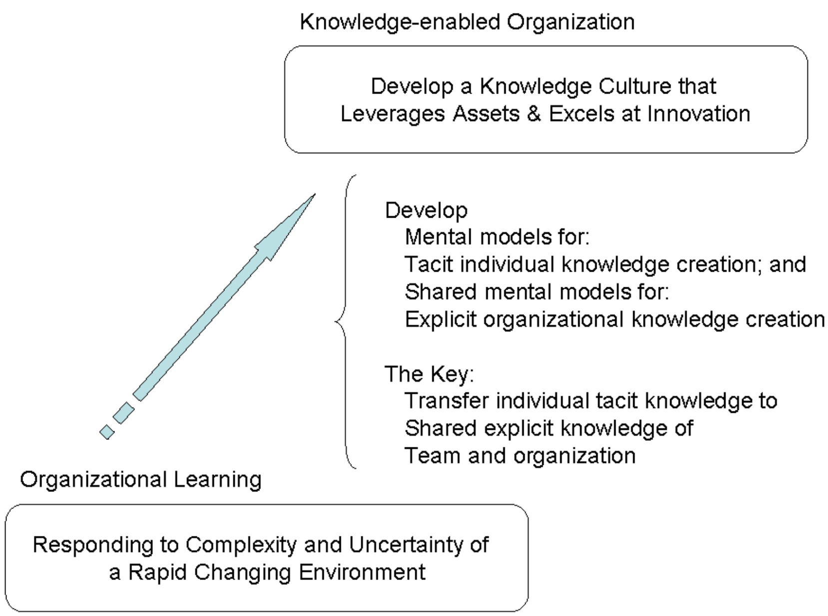

Figure 23: From Organizational Learning to a Knowledge-enabled Organization

The key ingredient of organisational learning is the ability to transfer individual tacit knowledge to shared explicit knowledge and spread it across the organisation. Tobin (1998) states: "***When a company learns to utilise and foster the growth of the knowledge and skills of all employees across all functions and levels, integrate learning activities into every employee's work, encourage and reinforce all modes of learning, and align all of this learning with the company's strategic business directions, it becomes a knowledge-enabled organisation***".

Tobin (1998) states that a knowledge-enabled organisation is one in which:

- The company recognises that the collective knowledge and skills of its employees provide the company's only source of competitive advantage.
- The company uses the knowledge and skills of all employees, regardless of level, function, or location, to help meet individual, functional, department, and overall company goals.
- Every employee has the means to locate the knowledge and skills of other employees to improve individual and company performance.
- The company provides just-in-time, just enough learning opportunities to all employees to enable them to gain the knowledge and skills needed to do their jobs.
- The company builds a culture that nurtures a positive learning environment.

Tobin argues that individuals and organizations learn through experience and discovery, which is supported by sharing knowledge and providing access to knowledge at the point of application where it is needed. He is convinced that the knowledge-enabled organization provides a more effective context and environment for continuous learning than large investments in training.

We want to add to this argument by re-emphasizing the model of Figure 18 in which we maintain that successful organizational learning and the knowledge-enabled organization is the result of a symbiosis of people (with their knowledge), businesses processes, and supporting technology. This is achieved through the successful learning cycle as illustrated in Figure 20.

5.4 Summary

In this chapter we described our view of the modern organization; its required focus on its stakeholders rather than only its shareholders – the so-called stakeholder capitalism versus shareholder capitalism; as well as the importance of learning and what the learning organization entails. We presented and proposed different models for ease of comprehension. They include the three domains of an organization (see Figure 18), the Enterprise Model (see Figure 19), and a model for the successful enterprise learning cycle (see Figure 20). We also emphasised the reality that individual learning takes place in the context of the organization (see Figure 22).

It should be clear from the descriptions that KM plays an important role in positioning the modern learning and knowledge-enabled organization to grow and survive in a highly competitive business environment.

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In the next chapter we discuss a key phenomenon important for KM, namely Communities of Practice.

Chapter 6 Knowledge Management and Communities of Practice

> ***Communities of practice are the new frontier. They may seem unfamiliar now, but in five or ten years they may be as common to discussions about organizations as business units and teams today – if managers learn how to make them a central part of their companies' success.*** – Etienne Wenger and Bill Snyder, Harvard Business Review, Jan-Feb 2000

In this chapter we begin with a brief overview of the notion of the knowledge workplace. Next we summarise the important aspect of KM's relationship to collaboration within the organisation and across organisation boundaries as an introduction to address the notion of a community of practice and its importance for KM. In Part 2 of the study we describe the notion of collaboration and its related KM technologies in detail.

6.1 The Knowledge Workplace

We briefly comment here on the evolving phenomenon of new experiences of physical and virtual workplaces for individuals and teams in organizations. We refer specifically to knowledge workers and the different forms of teams and communities of knowledge workers.

As we argued in previous sections, knowledge work is becoming the primary work style in enterprises, and knowledge workers are becoming the key element in the workforce. Fewer jobs are well-structured or well-defined. Instead, knowledge work is defined at the point of need – as and when opportunities, issues, and problems arise. Traditional hierarchical control structures can neither respond with sufficient agility to customer demands and competitive pressures nor satisfy the motivational needs of knowledge workers. The workplace must provide an environment in which the knowledge worker can most effectively perform his or her job. This environment may offer the following:

- supporting processes for analysis and decision making by individuals, teams, and communities;
- providing a means to collaborate with the appropriate people to accomplish the knowledge worker's task; and
- giving access to expertise, information, and knowledge assets that are relevant to the opportunity at hand.

The workplace is no longer just a physical location; it has become a blend of physical and virtual spaces in which work is undertaken[43]. People interact and collaborate with each other in physical and virtual places. Physical workplaces are about social interaction, which is an essential feature of

[43] This also supported by views of industry observers such as the Gartner Group.

creative and innovative efforts. Therefore, the knowledge workplace shifts the role of "place" as a control feature to "place" as a socialization and knowledge sharing medium.

In Part 2 of this study we will additionally discuss how this knowledge workplace is supported by KM technologies as well as the idea of whether KM can become mostly virtual.

Next we consider briefly the key KM concept of collaboration.

6.1 Knowledge Management and Collaboration

> ***Xerox's problem isn't with sharing knowledge – it's knowing who might want it or where to look for it.*** – Mary Bernhard (quoted in (Stewart, 2001))

Collaboration is the ability of groups of people to work together and exchange information and knowledge. Collaboration is a key part of the work activities of knowledge workers. The discipline of Computer Supported Collaborative Work (CSCW) is concerned with computing technology serving as support for groups of people as they work together. CSCW is specifically involved with ***human collaboration*** and supportive software that enhances cooperation, augments interpersonal communication, and supports distributed teams. We will describe this technology – which is a key KM technology in the form of "groupware" – in detail in Part 2 of this study.

Unlike traditional computing technology, which has a strictly technical focus, the focus of CSCW and groupware is on social and business situations as well as ***organizational collaboration***. The thinking is about the interrelationship of people, work, and technology as well as how to utilise technology such as groupware to stimulate innovations. Businesses which are primarily knowledge-based are keenly aware that leveraging the knowledge of employees and trading partners is the key to survival and success. They realise too that as a rough equation:

KM success = technology + culture + economics + politics

where the further one looks to the right of this equation the more difficult KM success becomes.

We propose in the diagram in Figure 24 a graphical illustration of the co-evolution of KM culture and technology as well as where and when KM and Communities of Practice are positioned.

Illustrated in the diagram is the evolution of corporate culture evolving into networked culture and to the e-mail culture which today is ubiquitous in corporations. In the early post-2000 years we are experiencing a huge increase in the adoption of collaboration technologies that can rightly be seen to be main contributors to the generation of knowledge as actionable information. Referring to Figure 24, we notice that the common thread through all stages is "collaboration", the ability to work together and exchange information and knowledge. It is about groups of business individuals and how they collaborate. We also notice a fundamental change in culture: the emergence of open communications between individuals and groups; bypassing many organizational structures and boundaries. A knowledge worker or a team of knowledge workers communicate directly with subject matter experts irrespective of their organizational ranking and position, driven mostly by the immediate project need for knowledge and information. MIT professor Allen's studies during the 1970s showed that hierarchical distance is as much of an inhibitor of knowledge sharing as physical distance (Stewart, 2001).

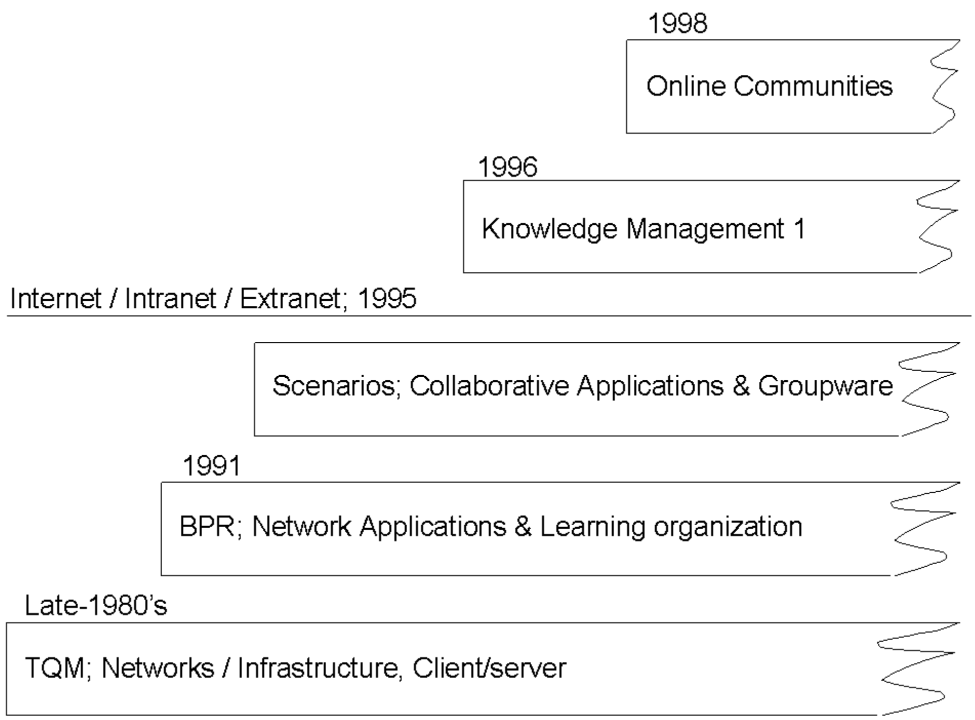


Figure 24: Evolution of Business Cultures and Knowledge Management Technologies

As companies start to organize, access, index, manage, and apply knowledge, knowledge tends to gather around two organizing principles: relationships and people. Organizations are now realizing the importance of these relationships and the people involved, and are starting to build communities. ***Most organizations now are a network of small communities***.

Therefore, we next describe the notion of Communities of Practice (CoP).

6.3 Communities of Practice – The Organizational Learning Space

In this section we describe the important aspect that is closely related to KM, namely communities of practice (often abbreviated as CoP). CoP and its relation to KM recently became a research focus[44].

6.3.1 Background

The concept of a community of practice[45] refers to the process of social learning that occurs when people who have a common interest in some subject or problem, collaborate to share ideas, find solutions, and build innovations.

The communities of practice concept was pioneered by the Institute for Research on Learning, a spin-off of the Xerox Palo Alto Research Center. The basic mission of the institute was to study how people learn. The term was first used in 1991 by Jean Lave and Etienne Wenger who used it in relation to situated learning. Their fundamental finding was that learning is a social activity – learning happens in groups. But, not every group is a learning place. Groups that learn, Communities of Practice, have special characteristics. They emerge of their own accord; drawn together by a force that is both social and professional. They collaborate directly, use one another as sounding boards, and teach each other.

In 1998, the theorist Etienne Wenger (http://www.ewenger.com) extended the concept and applied it to a commercial setting. More recently Communities of Practice have become associated with knowledge management as people have begun to see them as ways of cultivating or nurturing new knowledge or sharing existing tacit knowledge within an organization.

6.3.2 A Working Definition of Communities of Practice

We give here a view and a working definition of CoP that may be utilised in some KM project.

1. We can view a community of practice in terms of learning. This approach views learning as an act of membership in a "community of practice." The theory seeks to understand both the structure of communities and how learning occurs in them.

[44] Interested readers may consult a number of sources on CoP and closely related sources on CoP such as: Seely Brown and Duguid (1991, 2000), Katzenbach and Smith (1994), Burk (2000), Gongla and Rizzuto (2001), Lesser and Storck (2001), Kimble, Hildreth and Wright (2001), Wenger (2001), Malhotra (2002), and Hildreth and Kimble (2004).

[45] This is an organizational development (OD) concept. CoP is related to terms such as: communities of circumstance / interest / position / purpose (which we regard as out of scope for this study); also of virtual communities of practice. See www.mywiseowl.com/articles/Community_of_practice; online accessed July 2005; last updated 12 November 2004.

2. We use and support the following definition of a CoP as quoted by Stewart (2001):
"A CoP is a group of professionals, informally bound to one another through exposure to a common class of problems, common pursuit of solutions, and thereby themselves embodying a store of knowledge."

6.3.3 Basic Communities of Practice Concepts

The idea of communities of practice is based on the following assumptions:

- Learning is fundamentally a social phenomenon. People organize their learning around the social communities to which they belong. Therefore, schools are simply powerful learning environments for students whose social communities coincide with that school.
- Knowledge is integrated in the life of communities that share values, norms, languages, and ways of doing things. These are called communities of practice. Real knowledge is integrated in the doing, social relations, and expertise of these communities.
- The processes of learning and membership in a community of practice are inseparable. Because learning is intertwined with community membership, it is what lets us belong to and adjust our status in the group. As we change our learning, our identity – and our relationship to the group – changes.
- Knowledge is inseparable from practice. It is not possible to know without doing. By doing, we learn. (See Aristotle as quoted in online quotes Web site: www.quotations.about.com (accessed in April 2005).)
- Empowerment – or the ability to contribute to a community – creates the potential for learning. Circumstances in which we engage in real action that has consequences for both us and our community create the most powerful learning environments.

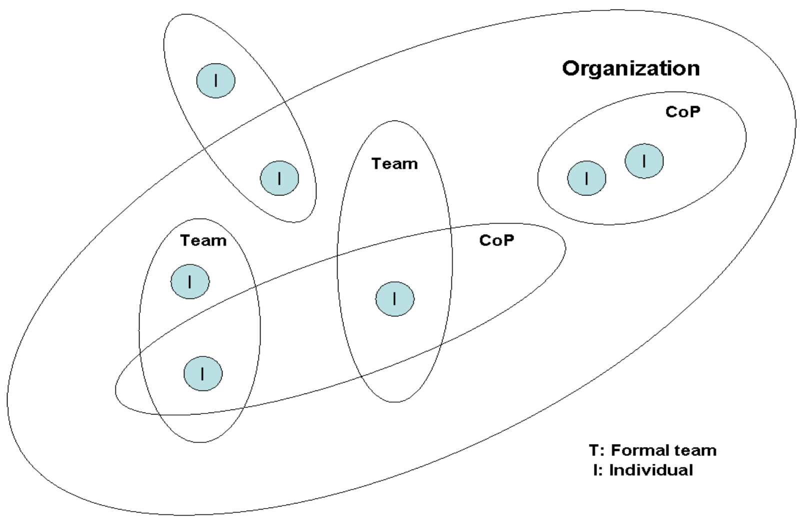
Communities of practice are simply expansions of one-on-one knowledge-sharing. Most people belong to a number of such communities, not all of them work-related. Some have names, such as the church choir or the neighbourhood council, and some may have no more of an identity than "***a group of management specialists who usually get together for lunch once a week***" (Burk, 2000).

While these ad-hoc communities are valuable knowledge-sharing mechanisms, they have real limitations. Knowledge passed in e-mail threads is lost when the threat ends. New staff or staff facing new problems are unaware of the ad-hoc communities and are unable to tap into their expertise. Lessons learned from experience are lost with retirement. Staff turnover and restructuring break down the informal networks to the point where even long-time staff do not know who to call. Innovative business organizations are therefore formalising these communities to create new mechanisms for creating, capturing, and sharing the knowledge that is critical to their success. With these communities of practice in place, this network emerges as the chartered source to build and deliver knowledge. By providing structure, support, and tools, leading organizations have enabled communities of practice to function far better than their informal predecessors.

Communities of practice are a crucial aspect of KM argues "Public Roads" the online web site of the US Department of Transport in May/June 2000, vol. 36, no. 6 (Burk, 2000).

> ***"At work, communities of practice can exist solely within an organizational unit; they can cross divisional and geographical boundaries; and they can even span several different companies or organizations. They can be made up of a handful of participants or many dozen. But they all tend to have a core group of participants whose dedication to the topic provides the energy needed to hold the group together. These core participants naturally provide the groups' intellectual and social leadership."***

The positioning of CoPs in and across organizations is illustrated in the next diagram.



Communities of practice differ from work teams in a significant way. Teams are formed by management and report to a boss. They have defined membership, deadlines, and specific deliverables. In contrast, communities of practice can be voluntary, usually have longer life spans than teams (but they only last as long as they have value to their members), and have no specific deliverables imposed. They are responsible largely to themselves.

Communities became the preferred method for groups of people that are distributed across time zones and working remotely – even across country boundaries – to communicate, collaborate, and share knowledge. These communities are typically connected through an online facility such as an intranet or extranet. The communities often act as the integration points for all knowledge services provided to its members. Typical communities include a leader to manage the community and a group of subject matter experts (SMEs) to contribute and evaluate knowledge assets within the community.

The services and functions provided in a typical online community include the following[46]:

- Community portals;
- e-mail management;
- Focus groups;
- Intellectual property, best practices, work examples, and template repository; and
- On-line events and ongoing training.

Members of communities are usually volunteers and different reward and other means are utilised to encourage knowledge sharing in the communities. This is a highly effective way to let members move past the old paradigm that knowledge is power and job security.

Through communities learners interpret, reflect, and form meaning. Communities are the joining of practice with analysis and reflection to share tacit understanding and to create shared knowledge from the experiences among participants in a learning opportunity. Communities provide the opportunity for the interaction; participation provides the learner with the meaning of the experience. In essence: ***learning becomes a process of reflecting, interpreting, and negotiating meaning among the participants of a community***.

6.3.4 The Link between Learning, Working, and Innovation

Seely Brown and Duguid (1991) contributed to the idea that there exists a close link between learning, working, and innovation. We quote them on some of the relevant ideas:

> ***"Working, learning, and innovating are closely related forms of human activity that are conventionally thought to conflict with each other. …***
>
> ***Much conventional learning theory, including that implicit in most training courses, tends to endorse the valuation of abstract knowledge over actual practice and, as a result, to separate learning from working and, more significantly, learners from workers.***
>
> ***… we view learning as the bridge between working and innovating.***
>
> ***… evolving communities-of-practice are significant sites of innovating."***
>
> ***"To foster working, learning, and innovating, an organization must close that gap. To do so, it needs to reconceive of itself as a community-of-communities, acknowledging in the process the many non-canonical communities in its midst. …***
>
> ***… to understand the way information is constructed and travels within an organization, it is first necessary to understand the different communities that are formed within it and the distribution of power among them. Conceptual reorganization to accommodate learning-in-working and innovation, then, must stretch from the level of individual communities-of-practice and the technology and practices used there to the level of the overarching organizational architecture, the community-of-communities. …***

[46] The applicable KM technologies are described in detail in Part2 of this study.

> ***Our argument is simply that for working, learning, and innovating to thrive collectively depends on linking these three, in theory and in practice, more closely, more realistically, and more reflectively than is generally the case at present."***

We illustrate this idea in the following diagram.

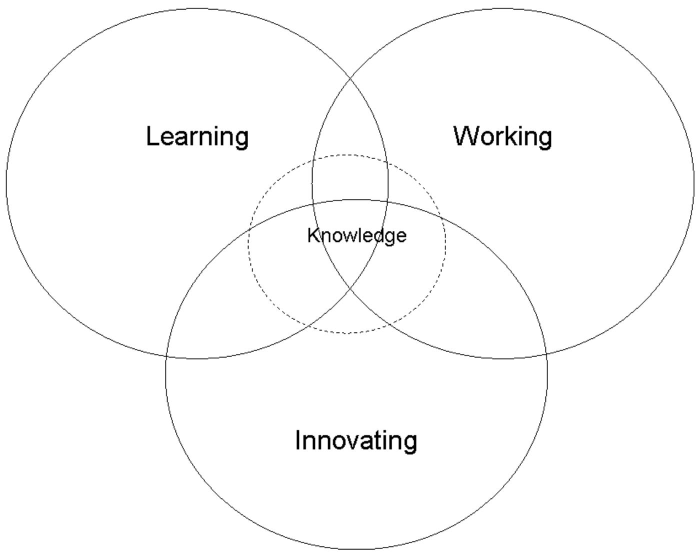


Figure 25: Learning, Working, and Innovation Interrelationships

We close this chapter by listing in summary some characteristics of CoPs.

6.3.4 Summary: Characteristics of Communities of Practice

The following characteristics distinguish CoPs from other groups[47]:

- They have history – they develop over time. You can define them in terms of the learning they do over time.
- Communities of Practice have an enterprise, but not an agenda – they form from a notion of "something we are doing".
- The enterprise involves learning – over time it develops customs and a culture.
- Communities of Practice are responsible only to themselves. No one owns them. Members join and stay because they have something to learn and something to contribute.
- Communities of Practice are voluntary and about fellowship rather than work.
- Communities of Practice perform two main jobs of human capital formation: knowledge transfer and innovation.

_ _ _ _ _ _ _

In the next chapter we address the issue of KM Best Practices and other practical issues.

[47] Source: Etienne Wenger as quoted by Stewart (1997).

Chapter 7 Knowledge Management Best Practices

> ***Every day that a better idea goes unused is a lost opportunity. We have to share more, and we have to share faster. I tell employees that sharing and using best practices is the single most important thing they can do.*** – Ken Derr, chairman and CEO, Chevron Corporation

O'Dell and Grayson (1998) argue that the actual learning process takes place via two main "soft" mechanisms: networks or CoPs (as we described in chapter 6) and best practices. In this section we consider the often quoted term of "best practices" that is encountered when operating in the KM field.

7.1 Best or Worse Practices Today?

> ***What is sensible today may be madness tomorrow.*** – Sveiby (www.sveiby.com)

In the consulting community the term "Best Practices" is often used (and sometimes misused) to select amongst a number of alternatives such as approaches, methods, procedures, standards, and technologies in cases where the complexity or the constraints of the business challenge or business situation justifies a selection based on previous experience or from a related similar situation. This term is used to justify or promote the reason for taking a specific stance or viewpoint about the business challenge. The use of best practices presumes that one can transplant the referred case directly onto this particular case. There exist reasons why this assumption can be proved wrong. First, there exist subtle differences between organizations that may invalidate the assumption. Second, we are facing the rapid change of the new millennium. Various authors are debating the applicability of best practices and point out what danger is included in taking this approach as a matter of fact rather than very cautiously. We are in accordance with this view when considering the rapid discontinuously changing environment we mentioned since chapter 1.

7.2 Knowledge Management in Practice – Success or Failure

Drawing upon lessons learned from the biggest failure of knowledge management recently and the debacle of the "new economy" enterprises, Malhotra (2004) explains why knowledge management systems (KMS) fail and how risk of such failures may be minimized. His key thesis is that KMS which are designed for the 'knowledge factory' engineering paradigm often unravel and become constraints in adapting and evolving such systems for business environments characterized by high uncertainty and radical discontinuous change. Design of KMS should therefore ensure that adaptation and innovation of business performance outcomes occur in alignment with the changing dynamics of the business environment. Malhotra states:

"Envisioning business models not only in terms of knowledge harvesting processes for seeking optimization and efficiencies, but in combination with ongoing knowledge creation processes would ensure that organizations not only succeed in doing the thing right in the short term but also in doing the right thing in the long term."

Managing knowledge and transferring best practices is conceptually simple, but difficult to execute. The steps in the knowledge transfer process are illustrated in Figure 26 (adapted from O'Dell and Grayson (1998) and aligned with the activities of our KM process model; see Figure 12 on page 44). According to O'Dell and Grayson every KM and transfer initiative should have the design approaches to address all of the steps indicated in the Knowledge Transfer Cycle.

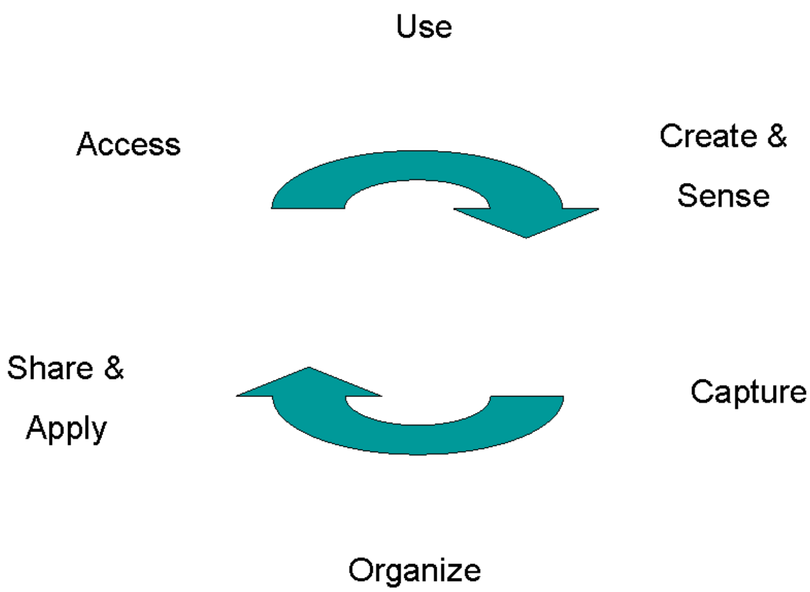


Figure 26: Knowledge Transfer Cycle

Best practices take information or data and put it in the context of real people and real experiences within the company. We learn by doing and by watching others do. The transfer of best practices helps others in the firm learn better, faster, and more effectively.

So our definition of best practices is as follows:

Best practices are those practices that have produces outstanding results in another situation and that could be adapted for our situation.

A term that includes the word "best" is inevitably the subject of debate, but the term "best practice" is widely recognised in the business world. O'Dell and Grayson (1998) observed Chevron that recognizes four levels of best practices in its corporate databases and best practice teams, namely:

- Good idea.
- Good practice.
- Local best practice.
- Industry best practice.

Contributors to these databases are responsible for deciding whether the practice is worth sharing with others and into which category of "best" such a practice should fit. O'Dell and Grayson also considered the barriers to internal transfer of knowledge, as follows:

> "***We believe most people have a natural desire to learn, to share what they know, and to make things better ... This natural desire is thwarted by a variety of logistical, structural, and cultural hurdles and deterrents present in our organizations. As a result, the actual process of identifying and transferring practices is trickier and more time-consuming than most people imagine. It must involve a conscious dismantling of these organizational barriers.***"

7.3 A Model for Best Practice Transfer

Illustrated in Figure 27 (adapted from O'Dell and Grayson (1998)) is the model for best practice transfer. The model has three major components which will be briefly discussed below, namely:

- Three value propositions;
- Four enablers; and
- The four-step change process.

The model is applicable to knowledge and practices about customers, products, processes, failures, and successes. It applies to explicit knowledge as well as tacit knowledge such as intuition, judgement, know-why, know-when, and know-how.

O'Dell and Grayson (1998) found that the reasons to engage in best practice transfer fall into three categories or the three ***value propositions***, namely[48]:

1. Customer intimacy
2. Product-to-market excellence
3. Operational excellence

Now consider the four enablers and the four-step change process.

[48] They describe these in detail in their book, but we consider them to be out of context of this study.

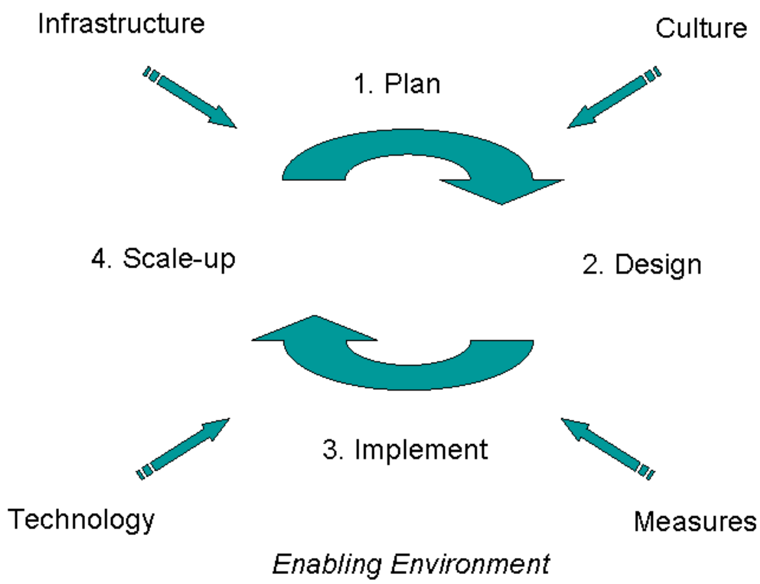


Figure 27: A Model for Best Practice Transfer

The Four Enablers

O'Dell and Grayson strongly maintain that the key reason why KM efforts fail is because the enablers of the KM process remain poorly understood and managed. These four enablers as shown in Figure 27 are:

1. Culture – Successful KM starts with a culture supportive of knowledge management or the leadership to create such a culture. This includes skills in teaming that includes cross-functional teams, and a common improvement approach such as the Baldrige Quality Award criteria; for example promoting knowledge sharing in its performance appraisal system.
2. Technology – The huge adoption of the Internet and intranet technologies turned out to be an enormous catalyst for knowledge sharing and distance learning. The key point here is that the advantages as well as the limitations of the technology should be recognised and should be appropriately employed.
3. Infrastructure – Leadership, a healthy culture, and basic IT are necessary prerequisites but not sufficient. Successful KM must be imbedded into the organization by creating new support systems, new teams, and collaboration.
4. Measures – This is the aspect of KM that is least understood and developed. But, it is important to measure projects and business processes that are being improved by using KM tools. The measures include having champions and facilitators, and a process for designing and managing change.

The Four-Phase Change Process

In general the change process as shown in Figure 27 should follow the following four phases:

1. Plan – This involves a self-assessment and a clear definition of the organization's value propositions.
2. Design – In the design phase the roles and functions of people and technologies and their relationships to organizational structure and performance measures are designed.
3. Implement – The implementation phase usually is done via a proof-of-concept which tests new ideas and teaches what is feasible and what not. During this phase "success stories" should be gathered to widely promote enthusiasm for KM.
4. Scale-up – After a successful pilot the pilot is scaled up to an enterprise-wide process to capture the full benefits of effective transfer.

7.3.5 Summary

The reasons for employing a KM strategy relate to the current rapid changing business environment. When appropriate best practices still play a role in the response required to the change challenge. We pointed out, however, that best practices should be employed with caution because of the fast changing business environment.

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This concludes our chapters that describe the "What is" and "Why is" characteristics of KM as the baseline for the description of this study about the "How" and "With what" of KM.

In the last chapter of this Part of the study we draw together a number of conclusions regarding the "What is" and "Why is" of KM.

Chapter 8 Summary and Conclusions of Part 1

After all is said and done much more will be said than done. – Anonymous

In the emerging economy a firm's only advantage is its ability to leverage and utilize its knowledge. – Larry Prusak

Knowledge Management is more of a strategy supported by technology that can show a quantifiable and sometimes substantial return on investment. – from The Knowledge Management Paybook (online) by Greg MacSweeney

8.1 Introduction

In Part 1 of this study we have focussed on the "What-is" and "Why-is" characteristics of the notions of knowledge and Knowledge Management.

We conclude Part 1 by summarizing the main points of these characteristics followed by the main conclusions we make about these characteristics as a baseline for the last Part of the study which describes the "How" and "With-what" of Knowledge Management.

8.2 A Summary of the Main Points of Part 1

Part 1 of this study was concerned with the "What-is" and "Why-is" characteristics of the terms "knowledge" and "knowledge management". We focussed specifically on modern organizations that do business in the challenging business environment of the 21st Century.

We argued that the current business environment has the characteristic of radical discontinuous change. This results in a highly competitive climate. The major competitive advantage an organization has is its knowledge expertise – it is the primary differentiator in this competitive business environment.

The idea of "knowledge management" is a contemporary response to the challenges of the economy in the new millennium. Even though humankind has perennially relied on knowledge for solutions, the recent emergence of, and emphasis on knowledge management as a critical topic, is rooted in technological developments. More specifically, it is related to the ease of access and affordability created by new technologies, primarily the set of Internet-based technologies.

KM is one of the key factors driving demand for IT in the new millennium.

From a business strategic perspective, Knowledge Management is about obsolescing what you know before others do, and profiting by creating the challenges and opportunities others haven't even thought about.

Various academic and practitioner approaches are still to emerge to clarify definitions and taxonomies for positioning knowledge management. At present there is some confusion amongst outsiders to the field as to what this KM phenomenon entails and how to comprehend various claims and issues related to it. We have proposed a set of models that jointly form a knowledge management framework for more clearly comprehending the many interrelated notions of this field of study.

We argued in this study that the list of models we have discussed, forms a framework against which we can more readily comprehend the notions and issues surrounding both knowledge and KM. These models introduce much clarity and insight into the "What-is" and "Why-is" characteristics of knowledge and KM and their related issues and aspects.

We have also argued for the ***need and appropriateness of KM technologies***. We do realise that these technologies are merely necessary but insufficient prerequisites for knowledge management. We will expand on this in depth in the last Part of this study.

We also emphasised the important role of learning by individuals (in their work context) as well as the importance of organizational learning.

We emphasised the close linking of knowledge, learning, working, and innovation and how those concepts relate to organizational communities of practice.

We pointed out the importance of collaborating amongst knowledge workers which should employ best practices cautiously where applicable.

In the following subsections we address the phenomenon of many viewpoints of knowledge and knowledge management as well as the prediction we can make about the future of KM.

8.2.1 Many Knowledge and Knowledge Management Viewpoints

There exist many viewpoints and perspectives on the notion of ***knowledge***. This in itself is a major contributor to the confusion about the term ***knowledge management***. While practicing in IT consulting situations the author was often exposed to the many viewpoints of different people who have vested interests in viewing the concept of knowledge from their respective expertise domains. These viewpoints can be summarised as follows:

- For human resource management: "***knowledge can only be in the minds of people***".
- For document management and librarians: "***knowledge is in documents***".
- For information system management: "***knowledge management is information management with the word information changed to knowledge***".
- For knowledge engineering: "***knowledge is something which can be captured in computer applications***".

Confusion is also fuelled by the many perspectives about the ***fundamental notions*** of knowledge and of knowledge management itself. These perspectives include the following:

- Philosophical – ideas of philosophers such as Polanyi; in contrast with
- Pragmatists – authors who view knowledge and knowledge management from their practical aspects and who are promoting the application of knowledge management as a response to the modern business challenges. These authors include Nonaka and Takeuchi, Stewart, Prusak and Davenport, Sveiby, and Malhotra – to name but a few of the authors we have referred to in this study.
- Managerial – The vast majority of perspectives should emphasise that the main focus should be about the people and managerial aspects of knowledge and knowledge management. We regarded the purely managerial aspects of knowledge management as out of scope of this study (although we were forced to hint at these aspects where applicable).
- The different perspectives that we selected to described in this Part in order to assist in clearing most of the confusion are:
  - The Conceptual perspective.
  - The Process perspective.
  - The Technology perspective (of which we presented an overview in Part 1 and will cover in depth in Part 2).
  - The Implementation perspective.

  We attempted in this Part to confine these viewpoints to more realistic and pragmatic views that are applicable and usable in responding to the many challenges that the modern organization are faced to overcome. One such view is our main premise that KM relies on KM technology as a necessary but not sufficient prerequisite.

Our study of knowledge management initially has led us to a bewildering number of viewpoints, perspectives, approaches, practices and some "theories". Academics and practitioners are aiming to reconcile and comprehend this new extension to some old ideas mixed with the reality of the new millennium and its rapid change characteristic. We argue that our "***framework of models***" clarifies many of the issues that present themselves in cases where such a framework is absent.

8.2.2 The Funnel Effect – Knowledge Management is "Just Business"

Judging from similar trends in the last few decades of various business approaches and strategies, it would seem that KM will eventually follow a similar route to those followed by a number of these approaches. In observing these trends we noticed that a number of business approaches are not being directly applied but indirectly considered to be "***just the way business should be done***". These techniques, approaches, and strategies have come to be regarded as "normal practice" and have been imbedded into the way business is perceived to be conducted.

We refer to this phenomenon as the "funnel effect". The funnel effect describes the convergence of different phenomena that become normal practice after other phenomena that are not robust enough to stand the test of time have been filtered out. We illustrate in Figure 28 the expected case where knowledge management too will become common place in the management of businesses and a view will emerge that: "***Knowledge management is just business***!"

8.2.3 Quo Vadis Knowledge Management? The Future of Knowledge Management

Knowledge Management seems likely to follow one of two paths. The better one is the direction taken by the quality movement and expert system technologies. Quality management has become imbedded in organizations, an integral element of organizational effectiveness. Expert systems nowadays are also very much imbedded in a variety of technological solutions. As Prusak (2001) states:

> "***KM may similarly be so thoroughly adopted – so much a natural part of how people organize work – that it eventually becomes invisible."***

The less appealing path would be to follow the Business Process Reengineering (BPR) route; "***becoming a byword for a crude, downsizing effort that rather does harm than improve the business" according to*** Prusak (2001). KM could follow the same path.

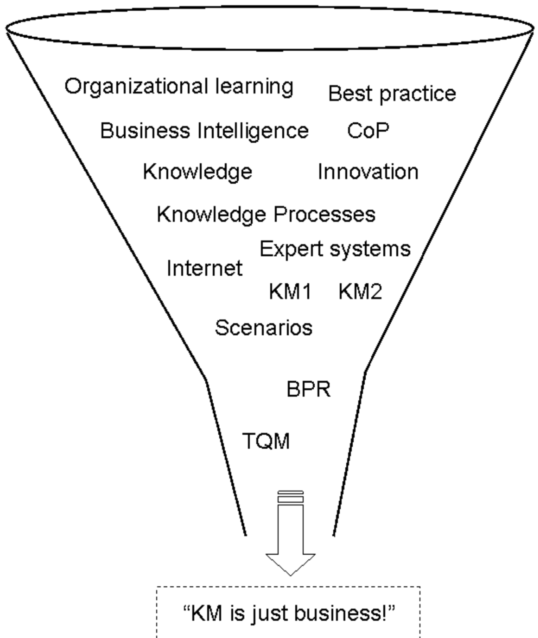

Figure 28: Knowledge Management Becomes "Just Business"

Will Knowledge Management Endure?

We may therefore rightly ask whether KM will endure. In this regard there are prominent authors who support our view that KM is here to stay. For example: Insightful work was done by Ponzi and Koenig (2002) who used an analytical framework for examining management fads.

They concluded that at the very least KM was not a management fad. Koenig (2005) re-examine this work and reconfirmed it by stating: "***KM is simply not a fad.***"

8.3 Knowledge Management-related Trends and Implications

Our prime thesis is summarised in the following list of key KM-related trends and implications:

1. The post-2000 era is characterized by rapid and discontinuous change in many aspects of the modern business environment – internal and external to the organization.
2. Modern business is forced to think beyond benchmarking and best practices to survive.
3. Promoting knowledge sharing – unlike typical information powerbases – will spawn innovation within the organization.
4. The pressure is constantly mounting on the organization urging it to **self-obsolete** marginal products and services before the competition does.
5. Knowledge and its "management" that result in business innovation is the prime differentiator for competitive advantage in a fiercely competitive and challenging new economy.
6. Stakeholder-focussed rather than shareholder-focussed strategies and execution will benefit the modern organization of the 21^{st} century in its quest for survival – quite a challenging task in itself.
7. Collaboration forms a key ingredient in managing knowledge processes. Transforming a business will require collaboration.
8. It became of key importance to recognize the value of and to manage communities of practice – turning organizations into communities of communities to foster organizational knowledge, learning, working, and innovation.
9. Learning, working, and innovation are closely linked and are essentially the same. Says Tapscott (1996): "***Increasingly, work and learning are becoming the same thing***." By implication it becomes obvious that the individual needs to adapt to the notion of "***life-long learning***"!
10. Lifelong learning of the individuals as knowledge workers; taking self-responsibility (individual responsibility) of the learning focus will spiral into the organization and will have the organization to evolve into a learning organization that will be a key prerequisite for KM and survival of the organization. Tapscott (1996) says:

    > "***Because the new economy is a knowledge economy and learning is part of day-to-day activity and life, both companies and individuals have found they need to take responsibility for learning simply to be effective.***
    >
    > ***And as you enter the digital economy, you become not only a knowledge worker but also a knowledge consumer. This places a considerable responsibility on each of us to invent our curriculum. We need to plan our Lifelong learning and how, through self-paced learning, on-the-job learning, and formal education and training, we can stay robust in a changing economy.***"
11. There exists at least two generations of KM. The first focused more on the technical aspects and on knowledge integration. The second is focusing on knowledge production

and integration but is more about human social behaviour, driven by individual and shared processes (Firestone and McElroy (2003)).

12. Innovation is becoming an imperative for enterprise agility and adaptability.
13. Awareness of the importance of intellectual capital is increasing.
14. KM will be required by most e-business initiatives.
15. KM requires a host of technologies that depend on the characteristics of the enterprise's KM programs. Says Debra Logan of Gartner Group (2001): "***KM-in-a-box is unlikely in the near term.***"
16. Finally, the knowledge workplace will affect every business — its personnel policies, management approaches and style, and workplace technologies.

8.4 Main Conclusions

We researched, explained, and motivated in this study why the subject of KM is of such a high importance for the organization in the new millennium and ultimately for its survival. The complexity of society and business, along with its acceleration in change, and the continuing redefinition of basic principles such as the nature of work, the modernisation of the economy and its globalization, the ever-changing demographics and related challenges in supply and demand, the onslaught of new entrants into established markets, and the leveraging effect in the explosion of new technology, information, and knowledge assets – leads us to conclude that ***KM is essential*** for the modern era in which we live and work.

We conclude therefore essentially and in summary with the following statements:

- KM is highly important for the survival of modern day knowledge-oriented organisations of the 21st century.
- KM can only be exercised or implemented or successful if a symbiosis / balance is assured between: the social, economic and ***technical*** aspects of KM.
- KM technology is evolving at a huge pace and there is no indication that this pace will diminish in the short to medium term (Koenig (2004, 2005)).
- Developing and enhancing KM technologies is the only way to at least being able to keep pace with the huge growth and change in knowledge assets that is most likely bound to accelerate evolutionary during the 21st century.

Thus: Ultimately, responsibility for "management" of knowledge and knowledge assets in the enterprise lies with every individual in the new knowledge-based economy. Knowledge Management technologies that enable and support these roles play a key role in a holistic view of this "management" of knowledge and of the knowledge assets of the enterprise.

8.4 Areas for Further Research

While studying this subject from our perspective and focus, we have notices and uncovered some areas for further research. These are:

- Further research in KM is vital for long term sustainability of the modern businesses operating in the evolving economies of the 21st century.
- The proposed sets of models and frameworks are practical tools for practitioners. Further research has to be done to ascertain the practical applicability and effectiveness of this framework.
- How useful is this framework for practitioners such as consultants and implementers?
- Further research would include developing construction and modelling tools to implement the frameworks.
- We are also observing the trend that knowledge technologies are increasingly been imbedded in other convergent technologies – in a very similar trend as what happened with Artificial Intelligence technologies in general and expert systems in particular. Will KM follow the same route or is it unique in some sense of the word?
- Investigate specifically how the emerging new emphasis of KM known as “The New Knowledge Management” of Firestone and McElroy (2003) affects the different KM technologies to be discussed in the last parts of this study.

End of Part 1

Part 2: The Technical Perspective of Knowledge Management

As we grow more familiar with the intelligent environment and learn to converse with it from the time we leave the cradle, we will begin to use computers with a grace and naturalness that is hard for us to imagine today.
And they will help all of us – not just a few "super-technocrats" – to think more deeply about ourselves and the world. – Alvin Toffler (1981)

... people are ... shocked today by the suggestion that machines can think,
but their dislike of the situation will not alter it in the least.
– Arthur C. Clarke - Profiles of the Future

The real danger is not that computers will begin to think like men,
but that men, will begin to think like computers. – S. J. Harris

About Part 2

In Part 2 we follow the indicated thesis structure as stipulated in the Preface, namely:
Part 1 – The "What-is" and "Why-is" characteristics of knowledge and knowledge management
Part 2 – The "How" and "With-what" characteristics

We focus on the technical aspects of knowledge management (KM). We propose our own KM technology framework that enables us to categorize the different KM technologies, enablers, and applications. We then position the applicable KM enablers and technologies. In closure we position the two key applications of KM, namely: knowledge portals and knowledge discovery.

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Chapter 1 Introduction

Where is the life we have lost in living?
Where is the wisdom we have lost in knowledge?
Where is the knowledge we have lost in information?
– T. S. Eliot, Choruses from "The Rock," I Collected Poems 1909-1919

Nothing is more rewarding than to watch someone who says it can't be done get interrupted by someone actually doing it. – Anonymous

How do we keep our latest innovation from being our last?
How do we keep our organisation as agile as a start-up?
How do we go from hindsight to foresight?
– "The Other IBM", IBM Business Consulting advertisement
Source: Fortune Special Issue – vol. 152, no. 5, 2005-09-21

The first section of this chapter introduces our main premise: technology plays a key role in KM acting as an enabler of KM. We then consider briefly what KM technology should and cannot do. In closure we position e-business relative to KM because of the tight link between these two concepts.

1.1 KM relies on KM Technology

Technology has given us new ways to keep in touch with each other and share information. We have to take advantage of that technology to get better, faster.
– Bill Baker, Texas Instruments

According to J. Jarlbaek, the Managing Partner of the Business Consulting Practice at Arthur Andersen Denmark they are using a knowledge equation:

"$K = (P + I)^S$. This simple equation is the basis of our efforts to manage knowledge effectively and be competitive in the information age.
We see knowledge (K) as being captured by people's (P) ability to exchange information (I) by utilizing technology (+), exponentially enhanced by the power of sharing (S). The power of this simple equation is tremendous. It is clear and it has universal appeal. When you explain it so someone, everything make sense, everything falls in place!" (Dutta and de Meyer (2001))

We attempted in this study to confine many viewpoints about the notions of knowledge and knowledge management to more realistic and pragmatic views that are applicable and usable in responding to the many challenges that modern organizations face. One such view is our main premise that KM relies on KM technology as **a necessary but not sufficient prerequisite** and that KM technology is an **enabler of KM**. We take notice of a number of authors who maintain that KM is not "a ***technology thing***" or "a ***computer thing***". Even early in the 1990s Newman (1991, 1996) has stated for example:

> ***"Knowledge management is the collection of processes that govern the creation, dissemination, and utilization of knowledge. In one form or another, knowledge management has been around for a very long time. Practitioners have included philosophers, priests, teachers, politicians, scribes, Liberians, etc.***
>
> ***So if knowledge management is such an ageless and broad topic what role does it serve in today's Information Age? These processes exist whether we acknowledge them or not and they have a profound effect on the decisions we make and the actions we take, both of which are enabled by knowledge of some type. If this is the case, and we agree that many of our decisions and actions have profound and long lasting effects, it makes sense to recognize and understand the processes that effect our actions and decisions and, where possible, take steps to improve the quality of these processes and in turn improve the quality of those actions and decisions for which we are responsible?***
>
> ***Knowledge management is not a, "a technology thing" or a, "computer thing". If we accept the premise that knowledge management is concerned with the entire process of discovery and creation of knowledge, dissemination of knowledge, and the utilization of knowledge then we are strongly driven to accept that knowledge management is much more than a "technology thing" and that elements of it exist in each of our jobs."***

Today - in the beginning of the new millennium – we realise that modern business has in its possession ***far too much technology for business support*** to chose from. Usually business is not lacking the desire or need to exploit these technologies; neither does it lack the financial capability to acquire these technologies. What is frequently lacking, however, is access to enough skills to exploit the capabilities of this vast variety of available technology. Already there exists a variety of technologies for support in the field of knowledge management. Exploiting these technologies is, however, a complex mixture of proper management of tacit/human knowledge; of differentiating the management of explicit information versus knowledge artefacts and sources; and of having to manage the knowledge management support technologies.

The value of IT is recently being seriously debated – specifically its contribution to the "productivity" of the organisation. Obviously the application of IT has to be considered and varies widely within an organisation and between organisations. However, we argue that the organisation becomes a knowledge company when it employs IT beyond its mere number crunching and word processing capabilities – but rather at a "deeper level": where information is employed and exploited for its intrinsic value and semantics as well as for its usability for reaching conclusions and taking actions. This can be achieved in different ways, as pointed out by Stewart (1997, 2001), namely by:

- "Mining valuable detail".
- "Running simulations".
- "Making a business out of knowledge itself".

The two economists of MIT, Erik Brynjolfsson and Lorin Hitt, investigated in 1993 the return on investment in "***computer capital***" versus other capital equipment. They found an eight-to-one difference in favour of the former. Professor Frank Lichtenberg of Columbia University found that spending on R&D versus spending on new plant and equipment – or physical capital – returned eight times more. For example, a new machine that assists in improving old work delivers incremental improvement. In contrast, R&D leads the organisation to innovation which introduces new products and services that are usually more valuable than the replaced products and services (Stewart (1997, 2001)).

It is therefore important to note that knowledge management problems can typically not be solved by the deployment of a technology solution alone. As we pointed out in various ways in the introductory part of this study: the greatest difficulty in managing knowledge is "changing people's behaviour," and the biggest impediment to knowledge transfer is the "culture" within the organization[1]. As Logan (2001) has explained:

> ". . . ***the state of the art is such that many of the social aspects of work important in knowledge management cannot currently be addressed by technology. … Second, the coupling between behaviour and technology is two-way: the introduction of technology may influence the way individuals work."***

We argue in this study that compelling technology is and will remain a KM critical success factor. Keeping in mind what we introduced in Part 1, we can state that KM technology:

- Stimulates and supports sharing, collaboration and innovation.
- Nurtures collaboration and cultural change.
- Can be effectively employed to assist in the learning process which is so critical for KM.
- Augments the knowledge of individual knowledge worker's by providing access to the experiences, insights and ideas of other knowledge workers.

Many products and technologies can be used to support KM, and obviously their capabilities vary while different products also offer varying mixes of these capabilities. KM programs are likely to use a combination of products, and probably do not rely on all capabilities of each product.

[1] Various sources support our view in this regard; for example Davenport and Prusak (2000), Logan (2001), and Malhotra (2001).

Technology's most valuable role in KM lies in extending the reach and enhancing the speed of ***knowledge transfer***. KM technologies enable extraction of the knowledge of individual knowledge workers and structured it to be used by other members of the whole organization. KM technologies serve as a major enabler of KM throughout the life cycle of the KM process that we have described in Part 1.

– – – – – – –

In the next two sections we make brief remarks about the potentialities of technology for supporting KM as well as about what KM technologies cannot do.

1.2 What KM technologies should do

The knowledge content required for business decisions extends beyond enterprise organizational boundaries to the network of customers, supply chain partners, and also to the Internet with its virtual/ad hoc business relationships and communities of practice relationships. In an extended enterprise, knowledge sharing, creation, and application includes the people, communities, intellectual capital and processes of this business network. As enterprises begin to operate in this extended environment, the overload of information and urgency will drive the need for a KM discipline and for a technical environment that assists the knowledge user in segregating relevant, applicable knowledge from the information overload. KM tools should evolve to increasingly recognize user behaviours and act on their behalf as intelligent agents to distinguish relevant, valuable knowledge and deliver it automatically or on request. "***Technology will play an increasing role as cultural barriers fall; knowledge mapping, user profiling, business rules and so on become the prominent critical success factors***"[2].

In those cases where the organization already focuses on knowledge, technology can expand the capabilities of the access to knowledge and ease the problem of getting the right knowledge to the right person at the right time. The mere presence of KM technologies may even have a positive effect on the knowledge culture of the organization (Davenport and Prusak (2000)).

2 Comment made by presenter in a Gartner Group presentation on KM in 2003 (at South African IT symposium).

1.3 What KM Technologies cannot do

> "***The ability to learn new things – or learn to learn – is paramount today. Rather, the ability to unlearn what was learnt is necessary most of the time, which is not a very smooth process unless well led." –*** Joia (2001)
> ***"We thought we understood the equation, K = (P + I)^S, but as we go forward we continually discover new issues, interpretations and problems inside the equation. We are finding that knowledge management is not simply a task of building technological systems or collecting information. Questions are raised about our entire organization and about how people relate to each other. Our journey has only begun!" – Dutta and de Meyer*** (2001)

There exist limitations in any program of KM. As pointed out above, effective KM only results after extensive behavioural, cultural, and organizational change. Technology on its own is not enough to bring about these changes. Technology alone will not make an expert share his/her knowledge with others or create a learning organization. Technology is common in the domain of knowledge distribution, but ***"rarely enhances the process of knowledge use"*** (Davenport and Prusak (2000)). Technology can distribute the knowledge content to the user, but cannot ensure what he or she will do with the knowledge content.

One area of KM where KM technologies are still weak is the support for the process of ***<u>knowledge creation</u>***. Knowledge creation remains largely an act of individuals or groups with technology still playing a minor role. Certain technologies do support group knowledge creation such as a Group Decision Support Systems (GDSS) which supports a small group of people usually residing in the same location. A GDSS aims to create some form of group knowledge out of the group's expertise, employing techniques such as technology assisted group brain-storming. Future development most probably may improve the knowledge creation abilities of KM technologies.

Artificial intelligence and expert systems-based KM technologies are often said to deliver "***the right information to the right person at the right time***". However, as we have argued in Part 1, new business models marked by radical and discontinuous change make the task of predicting the right information, the right person, or the right time challenging. This is so because the notion of "right" keeps shifting[3]. AI and expert systems are often based upon the assumption that these systems store human intelligence and experience. Technologies such as databases and groupware applications store ***<u>static</u>*** data and information, but cannot store the rich schemas that people posses for making ***<u>dynamic</u>*** sense of data and information (Malhotra (2001b)).

Malhotra (2001b) notes that the static representation of data in databases, inferential logic of computer programs, and computer memories <u>lack</u> inherent <u>dynamic sense making capabilities</u> that

[3] This argument is further complicated as various views of this "definition" maintains that it is overly simplistic as we have pointed out before. See also Thomas et al (2001).

are increasingly relevant for emerging business environments. In contrast, given the dynamic subjective nature of human construction of meaning and the diversity of personal constructions, different meanings could be constructed from the same assemblage of data at the same time by different individuals.

> "***Likewise, different meanings could be construed at different times or by consideration of different contexts by the same person. . . .***
> ***Moreover, the data archived in technological "knowledge repositories" is rational, static and without context, and such systems cannot account for renewal of existing knowledge and creation of new knowledge***." (Malhotra (2001b))

We are in accordance with Marwick (2001) who has stated the following:

> ***"Sometimes in computer science 'knowledge management' is interpreted to mean the acquisition and use of knowledge by computers, but that is not the meaning used here. In any case, automatic extraction of deep knowledge (i.e. in a form that captures the majority of the meaning) from documents is an elusive goal."***

1.4 Positioning Knowledge Management and e-business

Major drivers of modern business include the realization that business can be conducted on a global scale (so-called globalization), that the organization can only survive if it adds value to its stakeholders, that there should be a low barrier to access its products and services, and that the customer is most important for its survival. In today's challenging environment it has become obvious that the modern solution involves a two-fold imperative: firstly, organizations should offer enhanced and low cost electronic access to the conduct of business activities; and secondly, organizations should evolve superior management of knowledge assets. This leads to development of new knowledge-focussed business models supported by a network computing based strategy and infrastructure. Various new economy trends support this solution such as:

- The worldwide deregulation of telecommunications.
- The rise of consumer power.
- New enterprise business models.
- Fast changing technology innovation.
- Evolving technology standards.
- The digitization of "everything".

The term "e-business" was first used and promoted by IBM in the middle to late 1990s to describe the concept of doing business using new electronic network-based business models that are based on doing electronic commerce (e-commerce), managing corporate content, and performing enhanced collaborative computing. (Thus: e-business = e-commerce + content management + collaborative computing.) The formal definition for e-business used by IBM is as follows:

"***e-business is any activity that connects critical business systems directly to their critical constituencies (customers, employees, vendors and suppliers) via intranets, extranets and over the world-wide web***."[4]

The concept of e-business suggests that organizations should transform themselves into electronic businesses (e-businesses) by establishing new cross-organizational network-based strategies, processes, business and IT architectures, and infrastructures. New systems should be built and executed accordingly. They should integrate with and enhance the existing environment. The result should be a focus on leveraging the new business models in terms of enhanced services and products available to these "***critical constituencies***". The core of this ability to leverage the new way of operation and doing business resides in the value of the organization's knowledge assets. The new business model depends heavily on reliable, consistent, correct and complete information and knowledge in the organization as well as a secure infrastructure to protect these valuable assets.

However, to become an e-business is not an easy task and may take a long time to achieve – specifically for large organizations that have well-established old economy culture, processes and strategies. Therefore, the implementation of this strategy should be done with caution by employing a practical approach of ***starting small and growing fast***. This can be illustrated by an expanding implementation spiral as illustrated in Figure 1 (adapted from various IBM documentation on e-business).

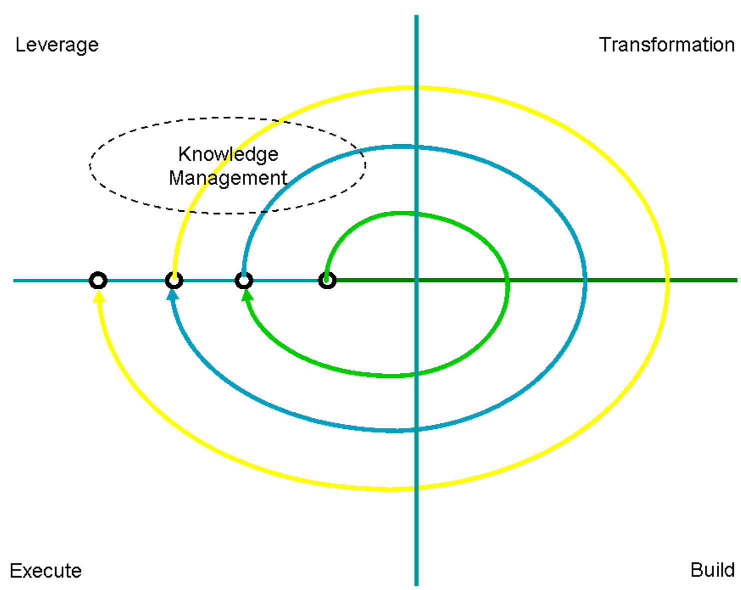

Figure 1: The e-business implementation spiral

[4] Published widely by IBM in various brochures and internal as well as external documentation.

The positioning of knowledge management within this e-business implementation spiral is largely in the upper left quadrant of the representation in Figure 1. KM from this perspective is thus a continuously revisited focus area with high emphasis on the leveraging of knowledge.

The key players involved in this leveraging of the knowledge assets are the knowledge workers. Managing the knowledge workers and the knowledge which they access becomes vital for organizations in the e-business economy. As articulated by Tapscott (1996):

> "***The new economy demands that companies change their business model, and the new technology enables it. ... However, in the new economy much of the effort of the new enterprise is knowledge work based on teams, changing human networks, new types of jobs, serendipitous communications, ad hoc collaboration, and brainstorming for innovation.***"

Therefore, in order to be successful with e-business, organizations are forced to regard knowledge management as a key strategy. This also implies that e-business mandates organizations to effectively employ knowledge management technologies.

In Table 1 we relate a list of the demands that result from an e-business initiative to the responses possible with knowledge management[5].

e-business	Knowledge management
Extends the enterprise and leverages its intellectual capital to customers and business partners, allowing these external parties to interact more directly with internal enterprise systems.	Supports making tacit knowledge explicit and IT systems more responsible for interactions. The result is less dependence on intermediaries that compensate for inadequacies in formal procedures and systems.
Demands increased customer and partner intimacy over new channels.	Sharing knowledge is possibly poorly developed in most enterprises.
Expands the competitive arena and also requires greater inventiveness and improved competitive intelligence.	Greater inventiveness and improved competitive intelligence are both KM focus areas.
Demands that knowledge be consolidated faster.	Drives organizational learning, innovation, and responsiveness.
Requires agility and adaptation to the changing environment.	KM and collaboration act as a platform for ongoing innovation

Table 1: KM responses to e-business demands

[5] This information was adapted from Logan (2001).

E-business has strong implications for the interaction between different processes and the integration of these processes. This interaction relies on the electronic means to enable connections between processes to take place in fundamentally new ways. This further happens at such speeds that it opens up the ability to radically reconfigure each core operating process in order to create new sub-processes to enable new modes of integration across the operating processes. The importance of e-business for processes is described by Fahey et al (2001). They illustrate these implications with interesting case studies such as that of Dell Computer Corporation's unique e-business model.

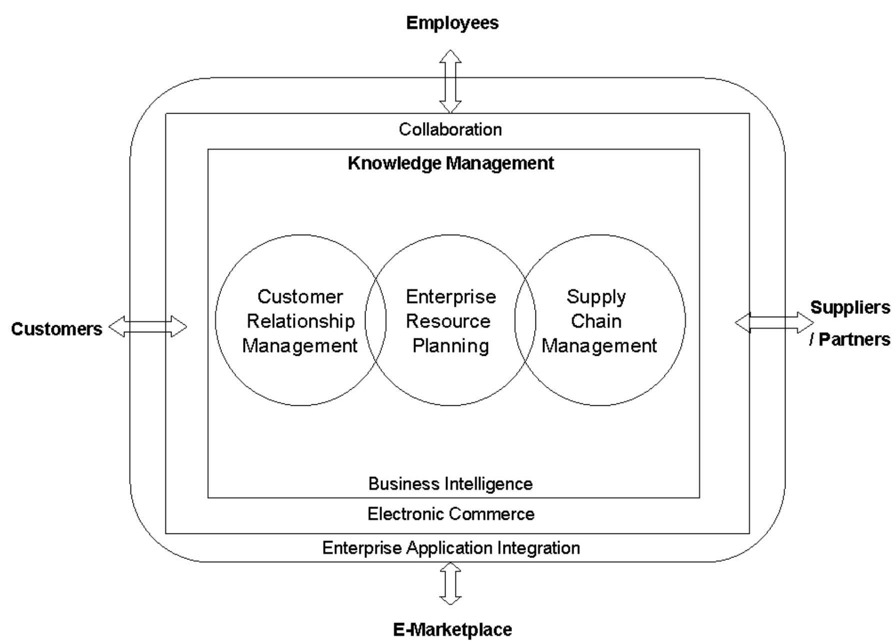

Figure 2: e-Business Model

Figure 2 highlights the positioning of KM relative to e-business in the e-business model[6]. The diagram includes a number of elements of importance for KM which we describe briefly in the following[7].

Customer relationship management

Customer Relationship Management (CRM) is the essential business process that encompasses an organization's end-to-end engagement with its customers over the lifetime of its relationship with them. CRM sub-processes include prospecting, marketing, sales, customer service, and support. These sub-processes cover all the ways in which customers and the business can interact (person to person, branch, call centre, kiosk, voice-response unit, ATM, and the Internet).

[6] Model adapted from various sources in IBM; see also Adams et al (2003).
[7] Sourced from Adams et al (2003)

Enterprise resource planning

Enterprise resource planning (ERP) provides the major back-office applications for many enterprises. Benefits of ERP include process automation and integration, and the availability of data to support business analysis.

Supply-chain management

Supply-chain management refers to a set of solutions that allows an enterprise to tie together the internal and external people and processes associated with its flow of goods.

Electronic commerce

Electronic commerce solutions allow enterprises to offer products and services to existing and new customers across new channels based on Internet technologies. They also provide the foundation for managing electronic transactions and allow customers to browse for and purchase goods and services with convenience and confidence, knowing that their transactions are secure and their privacy is protected.

Business intelligence

Business intelligence is the discipline of developing solutions that are conclusive, fact-based, and actionable. These solutions help the enterprises combine and analyze disparate data sources and derive valuable information from this data that provides key insights and data points that can be used to make informed and intelligent business decisions. These solutions typically include techniques such as data warehousing, data mining, and trend analysis.

Knowledge management

Knowledge management is the identification and analysis of available and required knowledge assets and related processes. It also includes the subsequent planning and control of actions to develop both the assets and the processes to fulfil organizational objectives. Knowledge assets are comprised of the knowledge regarding markets, products, technologies, and organizations that a business owns or needs to own and that enable its business processes to generate profits and provide value.

e-Marketplaces

e-Marketplaces are trading exchanges that facilitate and promote buying and selling, and enable business communities among trading partners within certain industries.

Collaboration

Doing business requires collaborative interaction among employees, vendors, suppliers, and business partners. A number of collaborative applications and solutions enable local work groups, or even geographically dispersed teams, to work together using real-time information sharing and distribution across the Internet. In addition to e-mail, these solutions include instant messaging, group calendaring and scheduling, shared document libraries, and discussion databases. (See the description of collaboration in chapter 5 "Knowledge Sharing and transfer" on page 54.)

Enterprise application integration

"***Integration and interoperability are critical for realizing the true potential of e-business solutions. Most "brick-and-mortar" enterprises have significant investments in legacy systems and ERP solutions. Thus, to be effective, it is important to integrate these e-business solutions with the ERP systems, legacy applications, and databases that might exist within the organization.***" (Adams et al (2003))

Implementing e-business solutions

e-business applications are different from the traditional client/server applications developed in the nineties. Table 2 illustrates the differences between these two types of applications (Adams et al (2003)).

	Traditional client/server applications	**e-business applications**
Reach	Within a department or enterprise	Across departments, enterprises, and geographic and national boundaries
Architectures	Deployed using a two- or three-tier architecture	Deployed using a thin client architecture with one to N back-end tiers
Programming model	Event-driven, with the application state managed at each client desktop	Thin browser-based clients, with the application state managed in the server layer
Network	LAN- or WAN-based	Based on LANs, WANs, private virtual networks, and Internet connections
Standards	Typical proprietary technologies	Open technologies
Number of users	Predictable user loads, from tens to hundreds	Unpredictable user loads, with massive deviations in the number of users

Table 2: Differences between client/server and e-business applications

The structure and nature of e-business solutions pose certain challenges to organizations that implement these solutions, including the following list[8]:

- ***A higher degree of integration***. e-business solutions typically implement radically new business processes and solutions that need to integrate and work with other systems in the enterprise, including legacy systems and databases or even with external systems.

[8] Covered in detail in Adams et al (2003).

- ***The need for speed***. These solutions typically have a very short window for implementation.
- ***Quality***. These solutions are designed to reach users beyond the enterprise, so it is extremely important to ensure the overall quality of the solution.
- ***The shortage of skills***. These complex solutions require considerable skills to develop and implement.
- ***Changing technology***. The Internet and its technologies are evolving rapidly, causing many interesting problems for enterprises trying to implement e-business solutions.

Adams et al (2003) maintains that:

> ***"Many hardware and software vendors in today's marketplace claim to have strategies and approaches that will help guide companies in their transition from an industrial economy to the digital economy. However, a closer look at many of these approaches shows that they are no more than a narrowly focused set of products thrown together to form a roadmap leading to the implementation of certain technologies. A truly powerful and viable strategy should be comprehensive and driven by all the facets of the business, supported effectively by technology."***

1.5 Summary

In essence then, KM technologies fulfil a supportive but highly important role in augmenting human capabilities in some important aspects of KM. It is important to remember that the true value of a KM system comes from ensuring that knowledge activities are supported and key business needs are met and that technology enables these endeavours. However, technology alone is not the answer. The sophisticated functionality offered by technologies today is only part of the promise of KM. KM remains a combination of business processes, organizational culture and technology – with technology having a major impact on the practice of knowledge management.

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We can derive three rules of thumb from the many sources and arguments stated so far, regarding knowledge and KM technologies, namely[9]:

1. The more "valuable" the knowledge, the less sophisticated the technology that supports it.
2. Tacit knowledge is best shared through people; explicit knowledge can be shared by KM technologies.
3. The more tacit the knowledge is, the less high-tech the required solution[10].

In the next chapter we develop and propose our knowledge management technology framework.

[9] Adapted from sources such as O'Dell and Grayson (1998)
[10] For example: consider discussion groups and help desks; the human knowledge in the help desk predominantly determines the success of it.

Chapter 2 The Knowledge Management Technology Framework

I don't fear computers. I fear the absence of computers. – Isaac Asimov

2.1 Introduction

In this chapter we propose a knowledge management technology framework (KMTF). We argue that this KMTF contributes to the comprehension of the notion of KM. The KMTF consolidates and expands many of the ideas and descriptions presented in Part 1. It also includes a number of categories of KM enablers consisting of KM technologies, infrastructure, and applications.

In the rest of this study we rely on this particular set of KMTF categories for guiding and structuring the chapters, thus describing the various KM enablers, as well as their relevant and mutual positioning to each other and to the overall notion of KM.

2.2 Developing the KM Technology Framework

As described in Part 1, knowledge management by definition is the management of the three different knowledge processes that we have identified, namely:

1. Knowledge creation and sensing.
2. Knowledge organizing and capturing.
3. Knowledge sharing and dissemination.

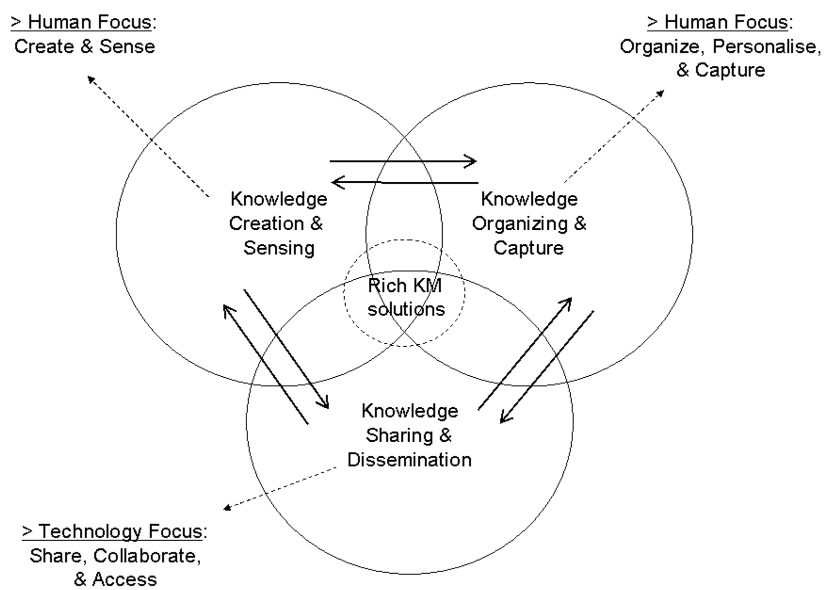

Figure 3: Knowledge Management Process Model

We have proposed a conceptual process model for KM in Part 1 as illustrated in Figure 3. In this part of the study we utilise the KM Process Model as a component of our proposed KM technology framework. The KM technology framework will be the general model we use to describe the position and value of the different relevant KM enablers, technologies, and applications.

Because KM technologies and products handle (explicit) knowledge instead of data they mostly either work with existing collections of text or promote collaborative work between knowledge workers. The latter enables the sharing of the unwritten knowledge in the minds of the knowledge workers. We start the framework development by considering the kind of information that knowledge workers handle and whether they know what to look for or not when additional knowledge is required. This approach leads us to initially categorize different KM technologies into three main categories, which will later be defined. This <u>initial schema</u> is depicted in Figure 4.

- Knowledge storage technologies (e.g. repositories) are used to make knowledge that one has available to others. One might say that these technologies are used in cases where "you know what knowledge you have".
- Knowledge sharing and transfer technologies are used to acquire knowledge that others already possess. One might cryptically say that these technologies are used in cases where "you know what knowledge you do not have".
- Knowledge discovery technologies are deployed to ratchet up, so to speak, knowledge storage technologies; to explore knowledge repositories and knowledge bases in such a way that new knowledge, implicit in the stored information, becomes known. One might express the matter by saying that these technologies are deployed when "you do not know what knowledge you have".
- The fourth category, knowledge generation, refers to the case where the knowledge worker does not know what knowledge he/she has. It implies that effort is directed at exploring, researching, and/or creating new knowledge.

Figure 4: KM broad categories

As we argued in different ways in Part 1, we can state that knowledge forms the core of the modern business. Therefore, our next step to develop the KM technology framework is to position the knowledge processes as a layer around the knowledge core. This layer includes the organization's leadership, strategy, culture, practices, and CoPs[11] since each of these has a bearing on the way in which the organization's knowledge processes are realized. Enclosing these, we propose, are two further layers: the third layer contains the different knowledge activities and the fourth, the KM enablers, applications, and technologies. These layers collectively form the conceptual model of the KM technology framework and are illustrated in Figure 5.

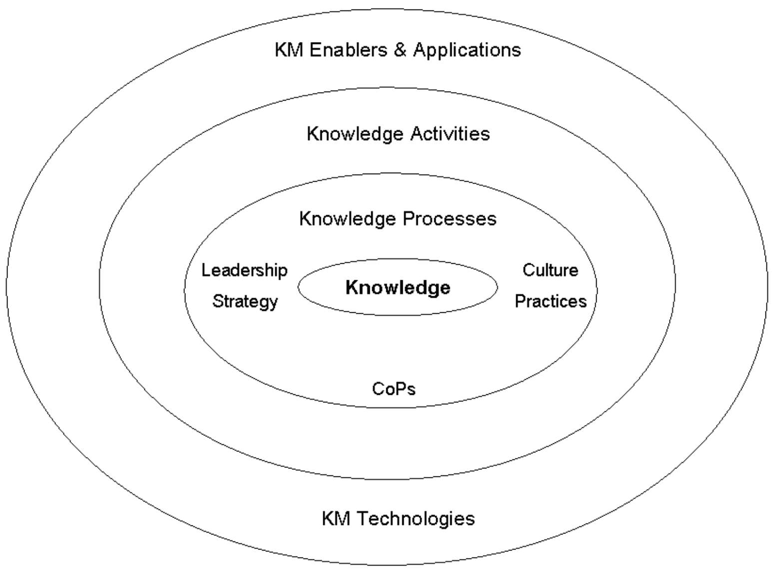

Figure 5: KM Technology Conceptual Framework

We next combine the KM process model and its related knowledge activities in Figure 3 into Figure 5 to obtain Figure 6 which displays the eight different knowledge activities.

In Figure 7 we list the most prominent KM enablers, applications, and technologies[12] in order to be able to categorize them as part of the framework.

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In the next two sections we first group these enablers and technologies into categories and then list the key identified KM applications.

[11] As described in Part 1: "CoPs" are the "communities of practice".
[12] This is a fairly complete but not exhaustive list.

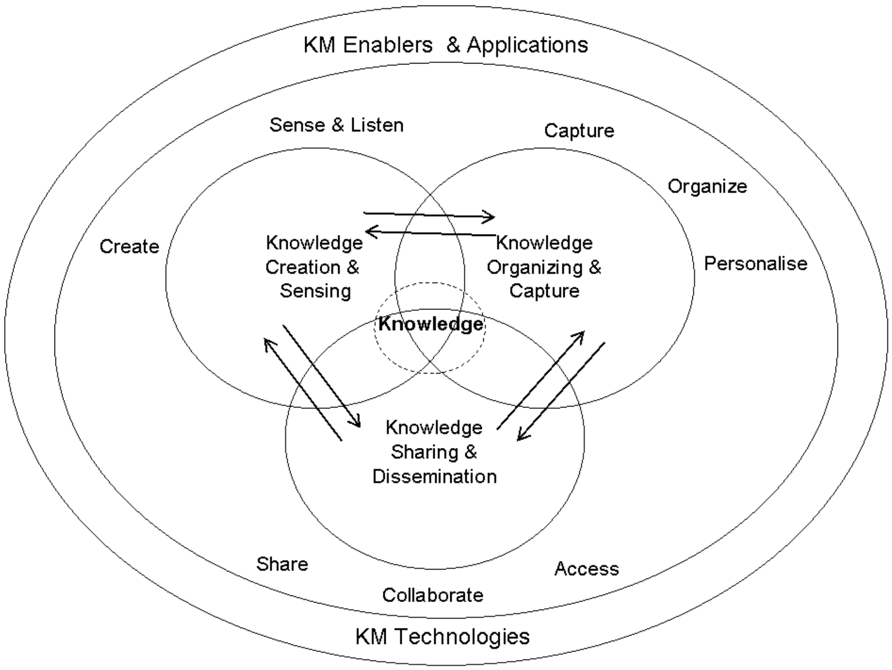

Figure 6: KM Technology Framework - processes and activities

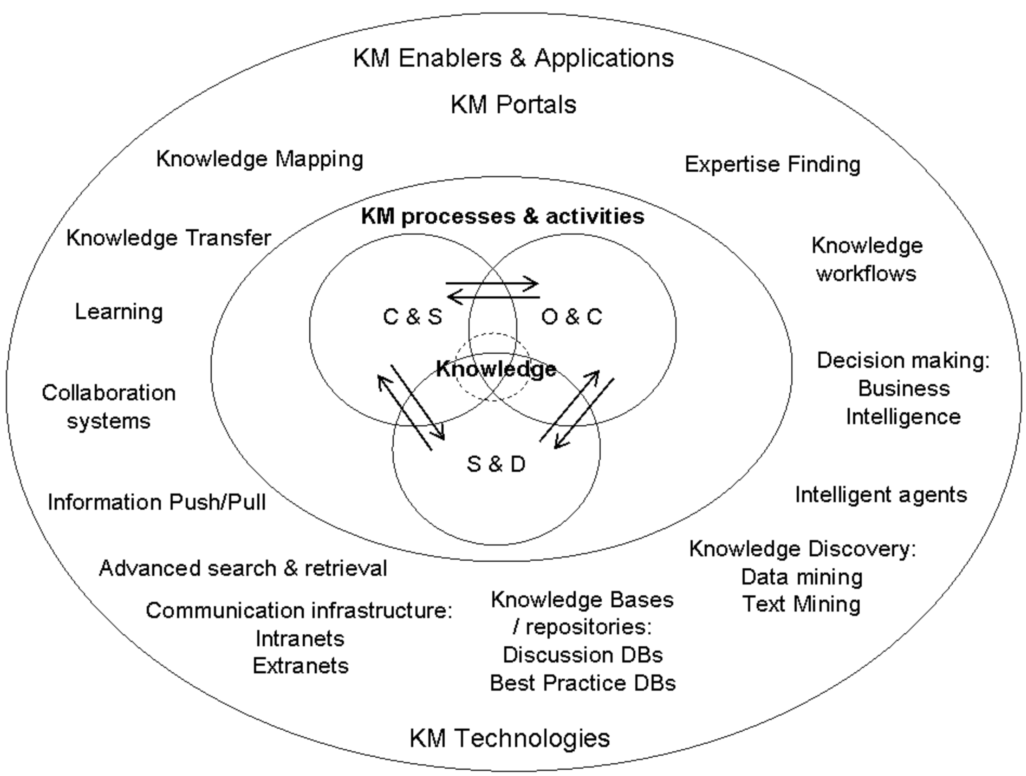

Figure 7: KM Technology Framework - enablers and applications

2.3 KM Technology Framework Categories Model

As one of our main contributions to the discipline of KM we categorise the different KM enablers, technologies, and applications that were depicted in Figure 7, into the following **six categories**. Four categories contain the KM enablers and technologies and two categories the key KM applications. The categories are:

KM enablers and technologies:

1. KMTF infrastructure
   This includes technologies for communication and knowledge bases; as well as technologies for knowledge organizing and capture.
2. Knowledge creation and sensing technologies.
3. Knowledge sharing and transfer technologies.
4. Advanced search and retrieval technologies.

KM applications:

5. Knowledge portals (as KMTF user interface and integration platform).
6. Knowledge discovery applications.

These categories are illustrated in Figure 8 which shows our KMTF 6 categories model. At the base of this model is the KMTF infrastructure which enables communication between knowledge workers and contains the different knowledge bases. This category also includes the technologies for the knowledge activities of capture and organizing.

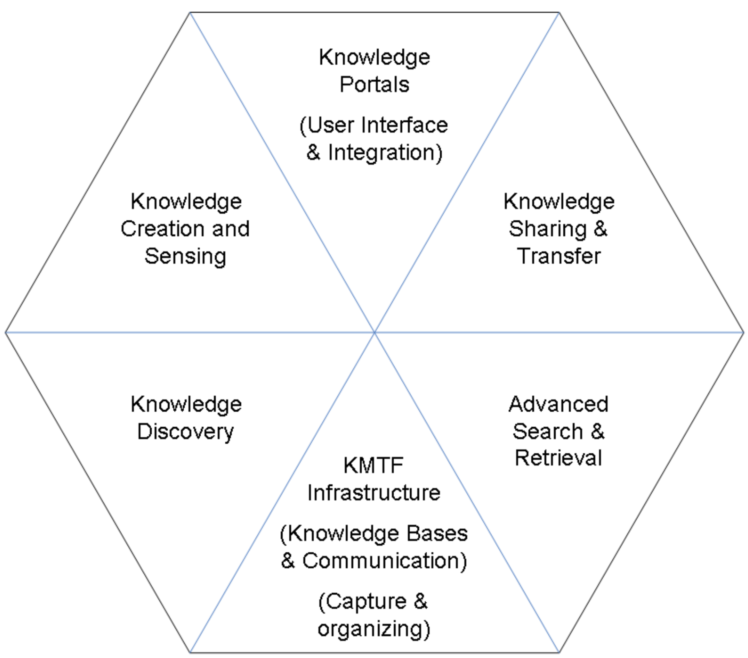

Figure 8: KMTF 6 Categories Model

The techniques and technologies of knowledge discovery applications explore the KMTF infrastructure. This is also the cases, albeit in a somewhat different way, for the advanced search and retrieval category. Each of these two categories logically supports the category above it. Thus, knowledge creation and sensing is supported by knowledge discovery while knowledge sharing and transfer is supported by advanced search and retrieval. The top category in the model is the visual interfacing and integration category consisting of the KM knowledge portals.

2.4 KM Technology Framework Enablers and Technologies

Summarised here is the overall content of the four enabler and technology categories of the KMTF. The descriptions of each of these categories are presented hereafter in the applicable chapters.

- KMTF Infrastructure
    - KM communication infrastructure
        - Intranets
        - Extranets
        - Internet-based technology
        - XML as data exchange technology
    - Knowledge Bases
        - Knowledge representation
            - o Semantic considerations
            - o XML as semantic technology
            - o Taxonomy and Ontology (Categorizing and segmenting)
        - Types of Knowledge Bases
            - o Discussion Knowledge Bases
            - o Intellectual capital and intellectual property Knowledge Bases
            - o Best practices Knowledge Bases
            - o Lessons-learned Knowledge Bases
            - o Research Knowledge Bases
            - o Corporate “Yellow Pages” Knowledge Bases
    - Knowledge harvesting process

- Knowledge Creation and Sensing
    - Sense making
    - Contextualizing / synthesis
    - Knowledge gathering (news feeds, pull, (search), data entry

- Knowledge Sharing and Transfer
    - Collaboration Systems
        - Push and pull technology
        - Groupware and e-mail
        - Synchronous messaging / live collaboration
    - e-learning and Web-based Instruction (WBI)
    - e-meetings
    - Technologies for the knowledge transfer cycle
        - Tacit to tacit
        - Tacit to explicit
        - Explicit to tacit
        - Explicit to explicit

- Advanced Search and Retrieval
    - Information overload
    - Intelligent search, NLP, natural language querying and questioning
    - Search engines
    - Searching, indexing and retrieval
        - Automatic indexing
        - Automatic thesaurus building
        - Content recognition
        - Summarization
    - Information and knowledge filtering
    - Linking; hypertext and hyperwords (liquid information)

2.5 KM Technology Framework Applications

We can identify a number of KM applications. We selected the following list as the key KM application categories to be studied. Of these four application categories, we cover the first two in depth but only summarise the categories of "expertise mapping and finding" and "analysis and decision making". Although the last category fulfils a key support role for KM, we regard it as a pure information technology application.

- KM Portals (KMTF user interface and integration)
  - Knowledge portals
  - Knowledge visualization
  - Enterprise Systems Integration
    - Expert systems
    - Document management systems and content management
    - BPM and workflow systems
    - ERP, CRM, and SCM

- Knowledge Discovery and Mapping
  - Knowledge mapping
  - Classification / navigation
  - Data mining
  - Text mining
  - Document mining
  - Intelligent agents & Internet "crawlers"

- Expertise mapping and finding
  - Knowledge workflow mapping
  - Expertise mapping and competency linking
  - Expertise network
  - Visualization
  - Affinity identification (locating CoPs)

- Analysis and decision making
  - Business intelligence (BI and BIKM)
  - Data Warehousing
  - OLAP (ROLAP, WOLAP, etc.); examine
  - Group decisions

Chapter 3 KM Technology Framework Infrastructure

There is the world of ideas and the world of practice. – Mathew Arnold

3.1 Introduction

The KMTF infrastructure that we describe in this chapter consists of the communication infrastructure (described in section 3.2) and the different types of knowledge bases (discussed in section 3.3) that serve as the primary (explicit) knowledge repository. We also include in the description of this infrastructure, and discuss in section 3.4, the process required to so-called "harvest" the knowledge from the organization's knowledge processes and repositories.

Broadly speaking, one might say that the KMTF infrastructure constitutes enablers of the "capture and organize" knowledge activities that were depicted in Figure 6 above.

3.2 Communication Infrastructure

Most successful organizations realise the need and importance of an explicit knowledge infrastructure to assist the transfer of knowledge. The transfer would never happen without a process and an infrastructure of people and technology to facilitate the process.

The concept of a KM infrastructure includes the transfer-specific mechanisms put in place to ensure the flow of knowledge and best practice through the organization[13]. These mechanisms include technology, work processes, and networks of people (communities); as well as needed organizational structures.

Judging from the description of the business challenges we have described so far, we suggest that technologies that should be included as enablers for KM should at least include the following:

- Fast, cheap, and wide bandwidth communications.
- Internet-type technologies and intranets.
- Interactive multimedia.
- Human-centred interfaces.
- Intelligent agents.
- Collaboration tools.

These infrastructural technologies should be integrated together in a seamless fashion.

[13] See also O'Dell and Grayson (1998), chapter 11: "Creating the knowledge infrastructure".

KM requires communication between the knowledge workers within the various communities that extends across the enterprise and even across organizational boundaries. This degree of "reach"[14] has become readily available in the form of Internet-based technologies. These include communication infrastructures such as intranets, extranets, and the Internet itself. Internet-based technologies have proved to be relatively cheap and offer wide bandwidth communication. The speed and reliability of intranets are usually adequate, while extranets and the Internet itself are constantly being upgraded to be fast and reliable enough to address mission-critical requirements.

The communications for KM should provide either document-to-person or person-to-person linkages. **Document-to-person** is important for "codification strategies". In these cases the explicit knowledge is far more important than the tacit knowledge as the products or services are mostly standardized; for example, in searching and filtering applications (as described later).

Person-to-person is more a personalization strategy. In these cases the tacit knowledge is far more important than the explicit knowledge. The product or service is tailor-made to the needs of the client; for example, in collaboration and portal personalization applications (as described later).

This infrastructure is also a key prerequisite for the deployment of KM portals as we describe later. The main purpose of the KMTF communication infrastructure is thus to provide access for knowledge workers to other knowledge workers and to organizational knowledge.

3.3 Knowledge Bases

Organizations employ databases, repositories of various types, autonomous agents, and search methodologies to enable knowledge workers to access the knowledge they require. A number of authors have proposed definitions for knowledge repositories, such as the following two[15]:

"A knowledge repository organizes, and makes available to all employees basic information on the company's organization, products, services, customers, and business processes." – Tobin (1998)

"***A knowledge repository is an on-line, computer-based storehouse of expertise, knowledge, experience, and documentation about a particular domain of expertise. In creating a knowledge repository, knowledge is collected, summarized, and integrated across sources***." – Liebowitz and Beckman (1998)

In the subsections below, various themes relating to knowledge repositories (also known as knowledge bases) are discussed. These range from knowledge base concepts, to representational issues, to semantic, taxonomic and ontological considerations.

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[14] The term "reach" indicates the extent of participants in the connectivity; following Keen in the early 1990s.
[15] Sourced as examples from Liebowitz (1999)

3.3.1 Knowledge Base Concepts

A knowledge base – also known as a knowledge repository – is a special kind of database for knowledge management. Typical knowledge bases consist of explicit knowledge of the organization, embodied in such things as documentation about, and examples, of best practices; links to experts (including expert mapping and knowledge mapping); articles; white papers; user manuals; etc. The main function served by these knowledge bases is the encapsulation of data and information from sources such as newspapers, journals, analyst reports, other databases, field reports, the Internet, and presentations. A knowledge base should have a carefully designed classification structure, content format, and search engine[16].

Technology for KM typically utilizes a repository of unstructured, explicit knowledge in document format that is stored as full text and/or as abstracted artefacts. KM technology also enables access for knowledge workers to many internal and external knowledge bases. Many of these repositories have been available and accessible for a long time in the form of computerized databases of published material. Examples include Dialog, Lexis/Nexis, and Medline.

The best example of a broad knowledge repository is the Internet. The Internet resolves issues such as world wide knowledge access and independence of where the knowledge resides. But, this also creates the Internet problem that a searcher has to sift through a huge number of "hits" and has to judge the value or relevance of a particular item. Internet technologies are relatively immature and therefore one can assume that future improvements in more sophisticated search engines will probably enhance the Internet as a knowledge source.

The major types of knowledge structures that can be represented in knowledge repositories include the following list:

- Multi-media objects: Images (pictures and video), sounds and signals.
- Text – flat or hypertext.
- Data – relational or flat files.
- Document structures such as: forms and templates, reports, graphs and charts.
- Cases for case-based reasoning (CBR).
- Rules for rule-based reasoning (RBS).
- Processes – decomposable hierarchies, resources, performance characteristics.
- Models for model-based reasoning (MBR), frameworks and simulations.
- Learning material – tutorials, computer-based training (CBT), e-learning; and Web-based instruction (WBI) course material.
- Object hierarchies including taxonomies and ontology.

[16] Source: www.BambooWeb.com and O'Dell and Grayson (1998).

The typical knowledge base also contains numerous cross-links to represent relationships between different knowledge objects.

What should also be regarded as "unmanaged" organizational knowledge that can be valuable sources for corporate knowledge bases, can be termed "***personal knowledge bases***". Personal knowledge bases include stores such as the office automation document stores including e-mail stores, calendars, personal notebooks, telephone lists, contact lists, and office automation distribution lists, as well as personal computer directories and CD libraries. Organizations are obliged to motivate knowledge workers to co-ordinate and share these personal knowledge bases.

In Figure 9 we illustrate the complexity of the different knowledge stores that comprise the corporate knowledge base. This diagram neatly positions different KM repositories and concepts in relation to individual, organizational, and community content[17].

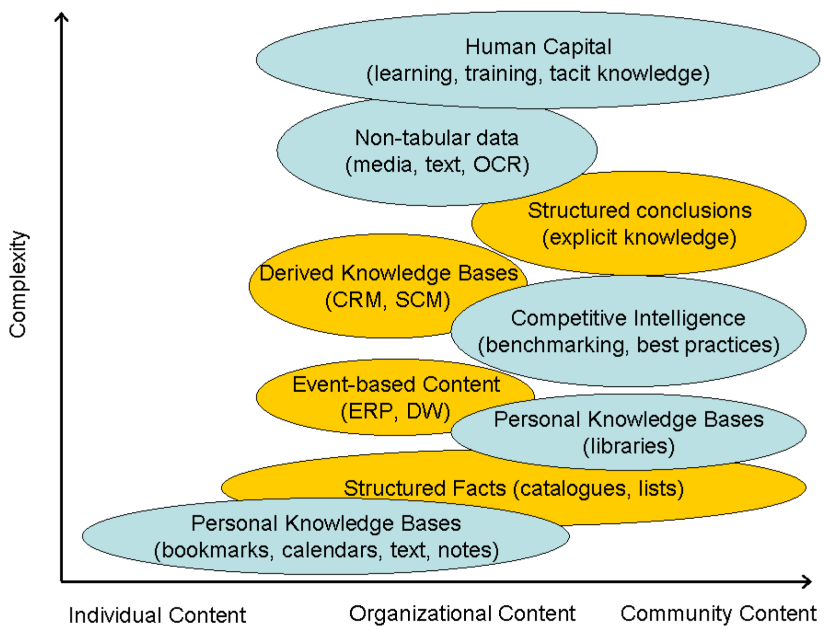

Figure 9: Complexity of different knowledge base sources

[17] Sourced online from www.DMReview.com by J. Ladley; last accessed: November 2005.

3.3.2 Knowledge Representation

Knowledge representation is a central problem in arranging knowledge[18]. Over a number of decades much research has been done to devise schemas to represent knowledge. The AI community, and specifically researchers into expert systems, have considered knowledge representation in depth. These efforts typically have concentrated on managing narrow domains of knowledge such as the configurations of computer systems or the diagnosis of a particular type of disease.

The reality of expert systems and artificial intelligence in business has been much less spectacular than originally anticipated, though certainly not without value. Improvements in technology for the foreseeable future will probably be evolutionary, rather than revolutionary with people largely augmenting knowledge-based technologies. (See also in this regard: Kourie (1994).)

The problem consists of how to store and manipulate knowledge in an information system in a formal way so that it may be used by mechanisms and knowledge workers to accomplish a given task. Examples of applications that rely on knowledge are expert systems, machine translation systems, computer-aided maintenance systems and information retrieval systems (including database front-ends).

One school of thought maintains that it would be best to represent knowledge in the same way that it is represented in the human mind. Alternatively, it is thought to represent knowledge in the form of human language. Unfortunately, we don't know how knowledge is represented in the human mind, or how to manipulate human languages in the same way as the human mind does.

In general, the language used for knowledge representation determines the kind of reasoning that can take place on the knowledge. The representation precedes reasoning. A knowledge representation language with limited expressivity cannot directly be used for automatic reasoning methods that require more complex expressiveness (Daconta et al (2003)).

For this reason, various artificial languages and notations have been proposed for representing knowledge. They are typically based on logic and mathematics, and have easily parsed grammars to ease machine processing. First-order predicate calculus is commonly used as a mathematical basis for these systems, to avoid excessive complexity. However, even simple systems based on this simple logic can be used to represent data where useful knowledge-based processing that relies on this data is well beyond the processing capability of current computer systems[19] [20].

[18] Sources include: www.BambooWeb.com.
[19] The case of the Prolog AI language is also a well-known example.
[20] Examples of notations:
- DATR is an example for representing lexical knowledge
- RDF is a simple notation for representing relationships between objects
Examples of artificial languages intended for knowledge representation include: CycL, Loom, OWL, and KM.

The recent fashion in knowledge representation languages is to use XML as the low-level syntax. This tends to make the output of these knowledge representation languages easy for machines to parse, at the expense of human readability.

Four General Knowledge Representation Schemas

Knowledge in artificial intelligence and expert systems, which sometimes play an important role in KM, can be represented as three general schemas, namely cases, rules, and models.

- Case-based reasoning (CBR) represents knowledge from experience such as events and specific case problems and solutions. CBR involves extraction of knowledge from a series of narratives, or cases, about the problem domain. CBR technology has been commercially successful in resolving customer service problems. Unlike expert systems, which require that rules are well structured with no overlaps, case structures can reflect the unorganized thinking that takes place in the human mind (Davenport and Prusak (2000)). Applications or tasks for CBR include planning, scheduling, design, legal reasoning, story understanding, and robot navigation; but the technology has not achieved broad business application in any of these areas.
- Rule-based systems (RBS) use knowledge compiled into related groups of statements and conditions, called rules, which represent heuristics that human experts often use to solve complex problems.
- Model-based reasoning (MBR) creates an overall framework through object technology for representing and organizing domain knowledge in terms of object attributes, behaviours, and relationships, as well as simulating domain processes.

A fourth schema, constraint-satisfaction reasoning, can be represented as a combination of RBS and MBR.

Techniques of Knowledge Representation

A number of techniques are used to represent knowledge. The three most common techniques have originated from artificial intelligence research on knowledge representation. They are <u>semantic networks</u>, <u>frames</u>, and <u>scripts</u> which we describe briefly here.

Semantic networks are used to represent knowledge as nodes and arcs. Each node represents a concept and the arcs are used to define relations between the concepts.

In early research, the **knowledge frame or just frame** has been used. A frame consists of slots which contain values; for instance, the frame for house might contain a “colour” slot, “number of floors” slot, etc. Frames can behave something like object-oriented programming languages, with inheritance of features described by the "is-a" link[21]. Other links include the "has-part" link. Frame structures are well-suited for the representation of schematic knowledge and stereotypical cognitive patterns. The elements of such schematic patterns are weighted unequally, attributing higher weights to the more typical elements of a schema. A pattern is activated by certain expectations: If a person sees a big bird, he or she will classify it rather as a sea eagle than a golden eagle, given his or her "sea-scheme" is currently activated[22]. Frames representations are more object-centred than semantic networks: all the facts and properties of a concept are located in one place – there is no need for costly search processes in the database. However, frames suffer from the frame problem of knowledge linking.

A **script** is a type of frame that describes what happens temporally ("time-sequenced"); the usual example given is that of describing going to a restaurant. The steps include waiting to be seated, receiving a menu, ordering, etc.

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Apart from the syntactic challenges of representing knowledge, the main challenge is to represent the meaning (semantics) of knowledge. This we cover and comment on next.
(Refer also to "sense making" in section 1.3 on page 8.)

3.3.3 Semantic Considerations, the Semantic Web and XML

In the KM process we deal mostly with natural language objects in the form of unstructured text and different document types that may contain mixed data and text including multi-media. One of the main challenges for KM technologies, therefore, is the issue of uncovering the semantics of the content. This is complicated further by the number of features of natural language that pose severe challenges. As an example:

> ***"Language ambiguity – most words have different meanings or semantics. An extreme example is the following. Time magazine of 27 March 1989 reported on the publication of the new Oxford English Dictionary and noted that the term 'set' contains the longest description in the dictionary. It defines 154 main meanings and more than 60000 words!"***
> (Botha (1991))

Semantic considerations are key issues for managing knowledge. In this section we address three themes related to KM's semantic challenge, namely:

- The semantic considerations of KM.
- The Semantic Web.

[21] However, there has been no small amount of inconsistency in the usage of the "is-a" link: Ronald J. Brachman wrote a paper titled "What IS-A is and isn't", wherein 29 different semantics were found in projects whose knowledge representation schemes involved an "is-a" link (www.BambooWeb.com).
[22] Source: www.BambooWeb.com.

- XML as the base technology for KM.

Semantic Considerations of KM

Much research has been done over the last few decades regarding the representation and processing of the semantics of data and information. The most notable progress recently made, focuses on the semantics of the huge volume of information residing on the Internet. The originator of the idea of the World Wide Web, Tim Berners-Lee, has a two-part vision for the future of the Web. The first part is to make the Web a more collaborative medium. The second part is to make the Web understandable, and therefore processable, by machines. This vision clearly involves more than retrieving HTML pages from Web servers as we are presently accustomed to doing. His original ideas require additional meta-data for processing the information on the Web.

For this to happen we need a paradigm shift in the way that we think about data and information (Daconta et al (2003)). The traditional approach used, is to see data as secondary to processing the data. Modern approaches involve object-oriented facilities that make data important internal to the applications. "***With the Web, Extensible Markup Language (XML), and the emerging Semantic Web, the shift of power is moving from applications to data***" according to Daconta et al (2003). Essentially, the data is made "smarter"; meaning that more meaning about the content is kept with information elements. The notion of "smarter data" is illustrated in Figure 10 as a data continuum consisting of four stages.

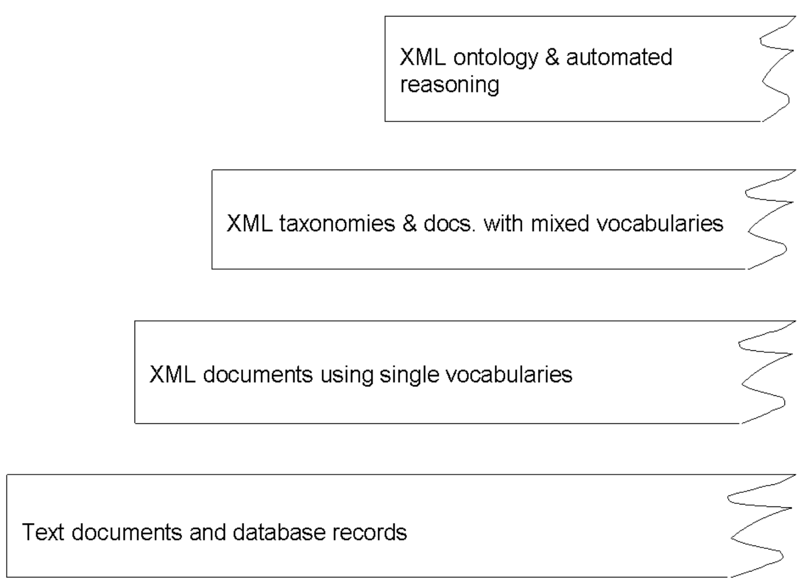

Figure 10: The "Smart" data continuum

Each progressive stage is being embodied with more semantic information for machines to make inferences about. These four stages of increased semantics are as follows:

Text and databases (pre-XML). The initial stage where most data is proprietary to an application. The meaning is determined by the application and not by the data.

XML documents for a single domain. The stage where data achieves application independence within a specific domain. Data possess enough meaning to be transferred between applications in a single domain or industry. "***An example of this would be the XML standards in the healthcare or insurance industry.***" (Daconta et al (2003)).

Taxonomies and documents with mixed vocabularies. In this stage, data can be composed from multiple domains and accurately classified in a hierarchical taxonomy. The classification can be used for discovery of data. Simple relationships between categories in the taxonomy can be used to relate and thus combine data. Therefore, data is now "smart" enough "***to be easily discovered and sensibly combined with other data.***" (Daconta et al (2003)).

Ontologies and rules. In this stage, new data can be inferred from existing data by following logical rules. In essence, data is now smart enough to be described with concrete relationships and sophisticated formalisms where logical calculations can be made on this algebra of "semantic logic". This allows the combination and recombination of data at a more atomic level and very fine-grained analysis of data. Therefore, with ontologies and rules as part of the data, data no longer exists as a blob but as information having meaning. An example of this data sophistication is the automatic translation of a document in one domain to the equivalent (or as close as possible) document in another domain.

Following this sequence of increasingly "smarter data" to another level one can conclude that this idea is a close fit for a number of challenges and issues faced in KM for which KM technologies play an important role. Developments such as these have potential to provide key benefits to KM. We should however caution that this is still early days for these developments and, as is usually the case with such phenomena, should be regarded as exploratory.

We next comment on the need for the Semantic Web.

The Semantic Web[23]

The Semantic Web is a project that intends to create a universal medium for information exchange by giving meaning, in a manner understandable by machines, to the content of documents on the Web. Currently under the direction of its creator, Tim Berners-Lee of the World Wide Web Consortium, the Semantic Web extends the ability of the World Wide Web through the use of standards, markup languages and related processing tools.

[23] Sourced from www.BambooWeb.com and Daconta et al (2003).

Relationship to the World Wide Web

Currently, the World Wide Web is based primarily on documents written in HTML, a language that is useful for describing, with an emphasis on visual presentation, a body of structured text interspersed with links to other documents and with multimedia objects such as images and interactive forms. HTML has limited ability to classify the blocks of text on a page or define the meaning (semantics) of the text, apart from the roles these blocks play in a typical document's organization and in the desired visual layout. For example, the HTML tags can only specify the positioning of the item known to the user as the "author" without having the semantic ability to interpret this item as referring to the author of this document or page.

The Semantic Web addresses this shortcoming, using the descriptive technologies RDF and OWL, and the data-centric, extensible mark-up language XML (see below). These technologies are combined in order to provide descriptions that supplement or replace the content of Web documents. Thus, content may manifest as descriptive data stored in Web-accessible databases, or as mark-up within documents (particularly, in XHTML interspersed with XML, or, more often, purely in XML, with layout/rendering cues stored separately). The machine-readable descriptions allow content managers to add meaning to the content, thereby facilitating automated information gathering and research by computers.

One of the main issues to be addressed by the Semantic Web is that current technologies are poor at content aggregation. Putting together information from disparate sources is a recurring problem in areas such as financial account aggregation, portal aggregation, and content mining[24].

XML as basic data interchange (and representation) language

Extensible Markup Language (XML) is emerging as a fundamental enabling technology for content management and application integration. XML is a set of rules for defining data structures. Unlike HTML, which specifies form of how things are presented, XML specifies the function of what things are. XML makes it possible for key elements in a document to be categorized according to meaning. It enables a search engine to scan a document for XML tags that identify individual pieces of text and image, instead of selecting and presenting a document based on a meta-tag found in the document header.

XML offers the possibility of a standards based approach to integrating many aspects of knowledge management technologies. XML brings together structured and unstructured information handling. As KM works to aggregate all this information and data, XML works to

[24] The latter two issues are addressed in the chapters that cover the KM portals and knowledge discovery.

categorize it. It enables advanced searching capabilities through a document's attributes, thereby increasing the speed and accuracy of searching. Ultimately, it is hoped that it enables new KM technology to offer new levels of dynamic content generation, integration, interoperability and functionality through a browser interface (Silver (2000)).

The Semantic Web and Web Services

Web services are software services identified by a Uniform Resource Identifier (URI). URIs are used as unique identifiers for concepts in the Semantic Web. The Web services URIs are described, discovered, and accessed using Web protocols. The important point here is that Web services often consume and produce XML-based documents and therefore further the adoption of XML and "smart data" (Daconta et al (2003)). Web services are likely to evolve into Semantic Web-enabled Web services. Web services also interact with other Web services.

> "***Advanced Web service applications involving comparison, composition, or orchestration of Web services will require Semantic Web technologies for such interactions to be automated.***" (Daconta et al (2003))

Figure 11 portrays the various convergences that need to combine to provide Semantic Web services (Daconta et al (2003)).

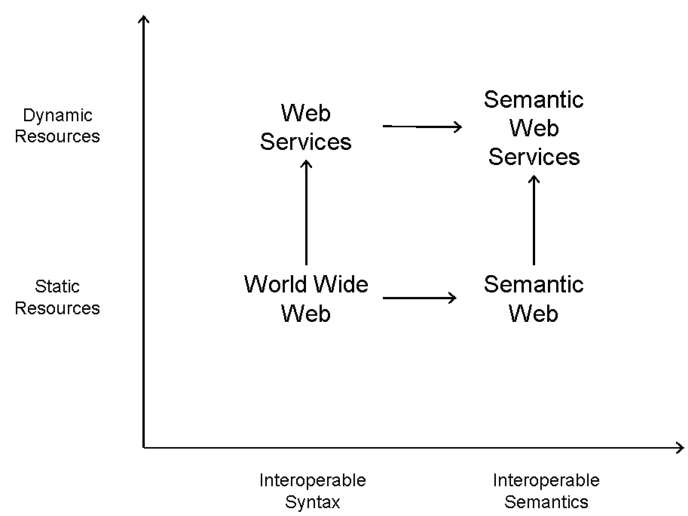

Figure 11: Semantic Web services

Daconta et al (2003) argue that Web services complete a platform-neutral processing model for XML. The step after that is to make both the data and the processing model smarter (i.e. more meaningful). They agree with a number of observers in the industry that there are likely to be five logical outflows of research related to the Semantic Web and Semantic Web Services. We discuss these in the next topic on taxonomy and ontology.

3.3.4 Taxonomy and Ontology / Categorizing and Segmenting

As described in the previous section, Web services play an important role as an enabler for the ideas of the Semantic Web and ultimately for KM technologies. The active research in this area focuses on furthering the idea of "smart data" to be evolved along a "smart data continuum" according to Daconta et al (2003). In the near term, we may expect to find important results of this research in five main areas, namely:

Logical assertions. An assertion is the smallest expression of useful information. One way to make an assertion is to model the key parts of a sentence by connecting a subject to an object with a verb. The Resource Description Framework (RDF) is designed to capture these associations between subjects and objects. As Tim Berners-Lee states:

> "***The philosophy was: What matters is in the connections. It isn't the letters, it's the way they're strung together into words. It isn't the words, it's the way they're strung together into phrases. It isn't the phrases, it's the way they're strung together into a document.***"[25]

Assertions are not free-form commentary but rather add logical statements to a resource or about a resource.

Rules. With XML, RDF, and inference rules, it is hoped that the Web can be transformed from a collection of documents into a knowledge base. An inference rule allows one to derive conclusions from a set of premises. For example: A well-known logic rule is called "modus ponens" and it states the following:

If P is ***true***, then Q is ***true***.
P is ***true***.
Therefore, Q is ***true***.

The Semantic Web is intended to use information in an ontology with logic rules to infer new information.

Trust. Instead of having trust determination as a binary operation of either having the correct credentials or not, trust can be determined better by adding semantics. For example, one may want to allow access to information if a trusted entity is a stand-in for a third party. Usage of a digital signature is crucial for the "web of trust" in digital security. By allowing anyone to make logical statements about resources, smart applications will only make inferences on statements that can be trusted. Thus, the ability to verify the sources of statements is a key part of the Semantic Web and therefore also of KM.

[25] Daconta et al (2003) quoting from Tim Berners-Lee's ***Weaving the Web***, Harper San Francisco.

Classification. We classify things to establish groupings by which generalizations can be made. Classification is done to better classify resources on corporate intranets and knowledge bases. Classification is strongly related to **taxonomy concepts** and specific **taxonomy models** such as XML Topic Maps (XTM). However, taxonomies are typically not standardised and lack rigorous logic which machines can use to make inferences from. That is the central difference between taxonomies and ontologies (which are discussed next). Figure 12 shows an example of a taxonomy that classifies the fox terrier Lady as a dog which is a mammal and thus an animal.

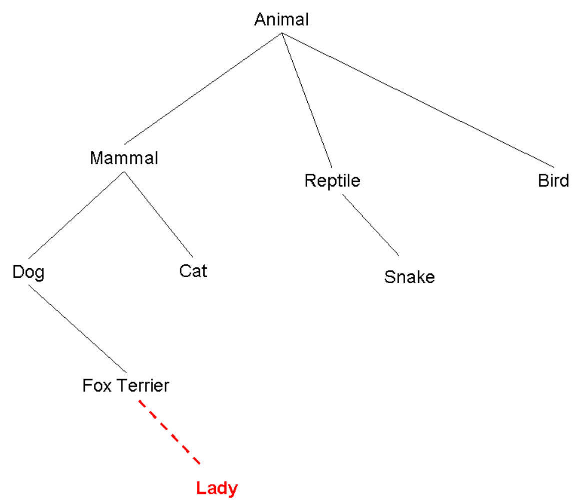

Figure 12: Example of a Taxonomy

Formal class models (ontologies). A formal representation of classes and relationships between classes to enable inference requires rigorous formalisms even beyond conventions used in current object-oriented programming languages such as Java and C++. Ontologies are used to represent such formal class hierarchies, constrained properties, and relations between classes. The W3C is developing a Web Ontology Language (abbreviated as OWL)[26].

Ontology

In computer science, an ontology is the result of an attempt to formulate an exhaustive and rigorous conceptual schema within a given domain, a typically hierarchical data structure containing all the relevant entities and their relationships and rules (theorems, regulations) within that domain[27]. This area of research is a relative new development for KM. There is much excitement and hype about the supposed value-add and potential for enabling KM of this technology.

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[26] The Web ontology language being developed by the W3C will have a UML presentation profile.

[27] The computer science usage of the term ontology is derived from the much older usage of the term in philosophy, where it means the study of being or existence as well as the basic categories thereof; sourced from sources such as: www.BambooWeb.com.

An ***ontology*** defines the common words and ***concepts*** (meanings) used to describe and represent an area of knowledge, and thereby standardizes the meanings. Ontologies are used by people, databases, and applications that need to share domain information. (A domain is just a specific subject area or area of knowledge, such as medicine, computer configuration, etc.) Ontologies include computer-usable definitions of basic concepts in the domain and the relationships among them. Because they ***encode knowledge*** in a domain, they make that knowledge **reusable**.

An ontology includes the following:

- Classes (general things) in the many domains of interest
- Instances (particular things)
- Relationships among those things
- Properties (and property values) of those things
- Functions of and processes involving those things
- Constraints on and rules involving those things

Ontology is often used in artificial intelligence and knowledge representation. Computer programs can use ontology for a variety of purposes including inductive reasoning, classification, a variety of problem solving techniques, as well as for facilitating communication and sharing of information between different systems.

An ontology which is not tied to a particular problem domain but attempts to describe general entities is known as a ***foundation ontology*** or upper ontology. Thus, foundation ontology is a core glossary in whose terms everything else must be described[28]. Typically, more specialized schema must be created to make the data useful for real world decisions.

Ontologies exist at three general levels: top level, middle level, and lower domain level. At the top level, the ontological information represented concerns primary semantic distinctions that apply to every ontology under the sun: These concern primary distinctions between tangible and intangible objects (objects that can be touched or held and those that cannot; or the distinction between abstract and concrete objects) as well as the semantics of parthood (i.e., what constitutes a part and what is the nature of those relations between parts and wholes). In many cases, there are multiple notions of parthood, some transitive, some not, some with other properties that need to be specified in an ontology and then inherited downward into the medium and lower domain levels of ontology representation.

The diagram[29] in Figure 13 depicts the three general levels of ontology. At the top is the upper ontology. This represents the common generic information that spans all ontologies. In the middle is the middle ontology. This level represents knowledge that spans domains and may not be as

[28] For example: "***the 2000 English words required by Longman's dictionary to define the 4000 most common English idioms***." – www.BambooWeb.com.

[29] Sources from Daconta et al (2003)

general at the knowledge of the upper level. Finally, the lower levels represent ontologies at the domain or sub-domain level. This is typically knowledge about more or less specific subject areas. In the figure, we point out the probable electronic commerce areas of interest, though one should note: in general, electronic commerce will be interested in all the ontology levels and areas, simply because commerce involves nearly everything.

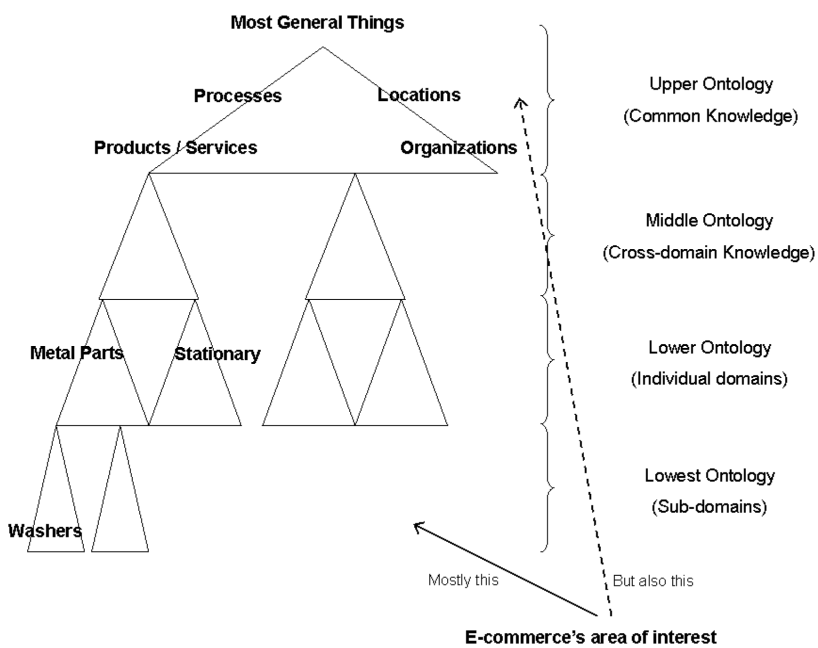

Figure 13: Ontology Levels

In the next section we combine many concepts mentioned so far into a so-called "ontology spectrum" that shows the positioning of these concepts ranging from weak to strong semantics.

3.3.5 The Ontology Spectrum

In this section we combine the many concepts that deal with semantics into a so-called "ontology spectrum". The following concepts all attempt to address issues in representing, classifying, and avoiding ambiguous meaning, namely: taxonomies, thesauri, conceptual models, and logical theories. The ontology spectrum is meant to depict these concepts in a general classification or ontology space, and displays the relationships among concepts such as "classification system", "taxonomy", "thesaurus", "ontology", "conceptual model", and "logical theory".

Figure 14 illustrates the ontology spectrum and also positions the well-known languages and technologies of the database models: the relational model, the entity-relationship language (ER), as well as the object-oriented model: Unified Modelling Language (UML). This model of the ontology spectrum is from Daconta et al (2003) and was developed for comparing the semantic richness of classification and knowledge-based models.

What is normally known as an ontology can thus range from the simple notion of a taxonomy (knowledge with minimal hierarchic or parent / child structure), to a thesaurus (words and relations such as synonyms), to a conceptual model (with more complex knowledge), to a local domain theory (with very rich, complex, consistent, meaningful knowledge).

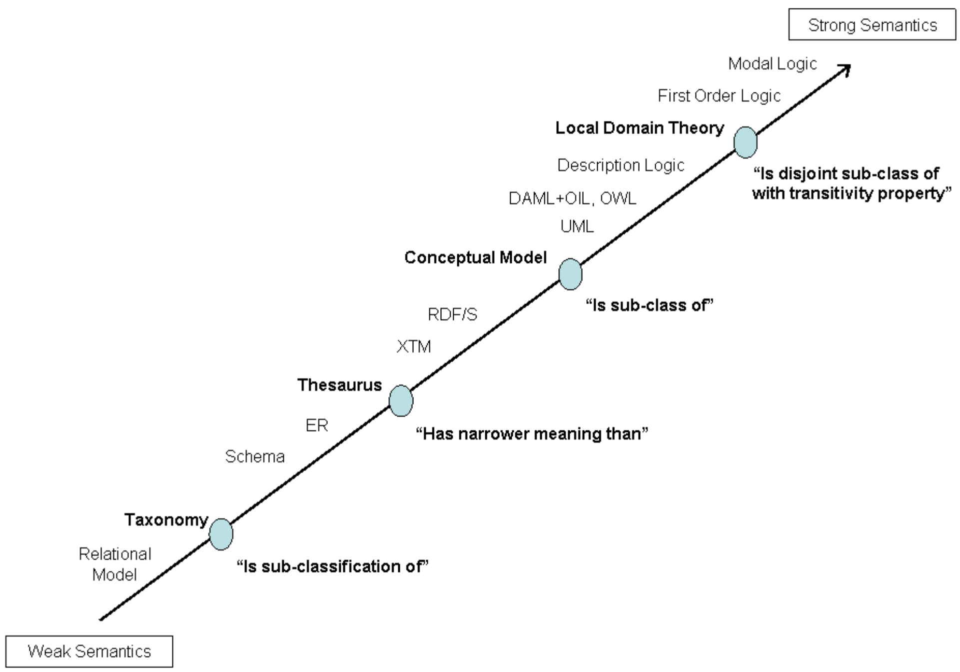

Figure 14: The Ontology Spectrum: from weak to strong semantics

We close this section with two summary diagrams – Figure 15 and Figure 16.

Figure 15 positions a range of concepts of knowledge representation and semantics by relating the types of meta-data and semantic annotations. As we move up this spectrum more semantics can be utilised for actionable information and business analytics. The technologies that support these levels of semantics are therefore strong candidates for enabling meaningful KM.
(This diagram was sourced and adapted online from www.DMReview.com by Ladley; last accessed: November 2005.)

Figure 16 shows the relationship of a number of the concepts discussed so far along with current developments in technology components and standards. The figure can be seen to show the possible architecture for actually building and deploying these concepts for KM. It relates the different technologies for the syntax of the data, the structure of the data, the semantic interpretation thereof, as well as the higher-order semantics and reasoning aspects. These layers of technologies can be combined into "intelligent" domain applications.

(This model was adapted from Maybury (2003).)

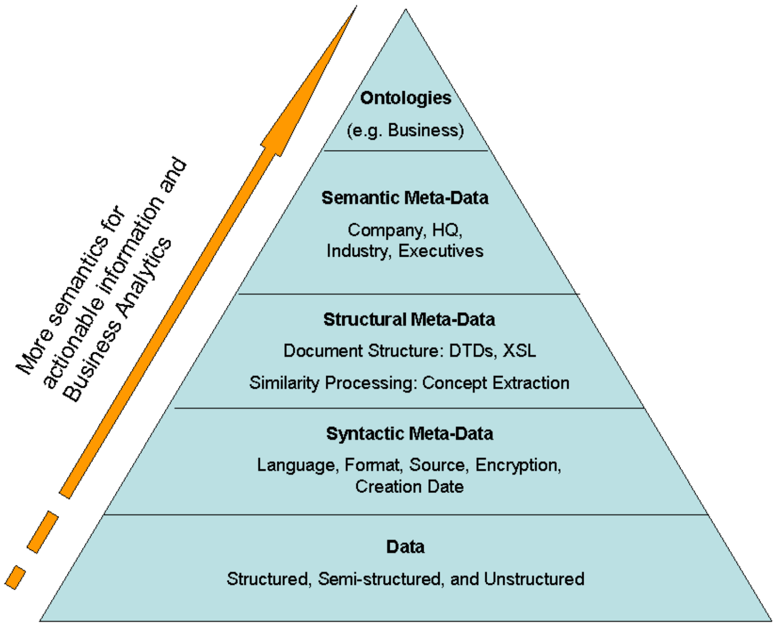

Figure 15: Meta Data and Semantic Annotations

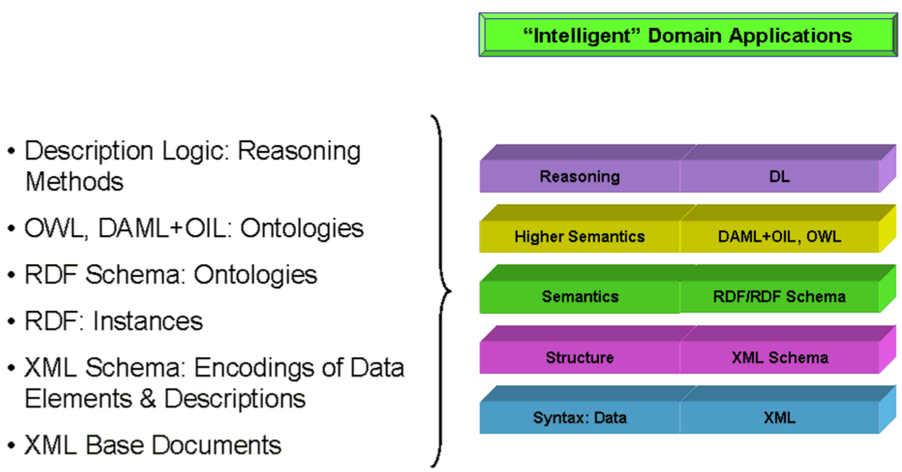

Figure 16: Positioning the XML Stack Architecture

3.3.6 Types of Knowledge Bases

In this section we discuss a number of the knowledge bases that organizations typically employ as well as two examples of how large organizations organize their corporate knowledge bases.

We start with the observation about the approaches of "push" versus "pull" dissemination of information. Stewart (1997) has cited a case study of Hewlett-Packard's (H-P) experience with "push" versus "pull" information. One has to distinguish between information that is pushed at knowledge workers and information that they pull for themselves. Typically, as Stewart (1997) articulates well:

> "… ***information is pushed at the knowledge worker. Standard reports – weekly sales numbers, monthly budget figures – land on their desks on a regular schedule; less formal documents like e-mail and memos pour in; other, undocumented stuff is told us at meetings, on the phone, by the coffeepot. Each of these – structured data, media, and people's knowledge – has a "pull" counterpart: Instead of being sent a report, you can have access, the ability to get it if you need it; documents can be placed in repositories like the databases discussed … instead of in in-boxes; corporate knowledge maps and Yellow Pages can help you pull in experts when you need them.***"

H-P has helped clear off employees 'desktops (both wood and silicon) by pushing less information and putting more where it can be pulled. As Stewart (1997) has stated:

> ***"Policies, phone directories, product descriptions (20,000 of them), and many internal reports go on-line. Rather than have publishers fulfil dozens or hundreds of individual subscriptions to magazines, newsletters, and data sources, H-P negotiates company-wide licenses and puts electronic versions into databases."***

Types of Knowledge Bases

The types of knowledge bases we cover in this section are:

- Corporate "Yellow Pages" knowledge base
- Intellectual capital and property (IC/IP) knowledge base
- Discussion knowledge base
- Best practices and Lessons-learned knowledge base

Corporate “Yellow Pages” Knowledge Base

Knowledge is growing so fast that any attempt to codify all of it becomes impractical. But, internal in the organization the identities of the knowledge workers change slowly. The challenge, however, is to locate (for example) those experts who posses the required knowledge for a particular requirements. Questions asked by knowledge workers include examples such as: “Who knows whether the contract with ABC Corp. covers repair services or not?” and “Who knows the contact details of the person who approached us about new business six months ago?” These questions may take hours to resolve. Organizations are therefore constructing and populating corporate “Yellow Pages” to assist in this regard. This type of knowledge base should be a simple system that connects inquirers to experts. This will obviously save time, reduce errors and guesswork and prevent the reinvention of countless wheels. Stewart (1997) also warns that this type of knowledge base should not be a giant index because specific information changes too quickly, but, should be maps that show where the knowledge of the enterprise is located and who is the “knower” (in whose head). Stewart (2001) investigated why only a few companies do employ these knowledge bases and again concluded that the rule remains: ***Knowledge projects must solve a business need***. This indicates that companies employ these knowledge bases but did not adequately address a specific business need and that the users therefore perceive the result as not worthwhile.

Therefore, a good Yellow Pages knowledge base can be a valuable knowledge project provided it adequately addresses a business need.

Intellectual capital and property (IC/IP) Knowledge Base

As discussed in Part 1 there are two kinds of intellectual capital:

- First, the semi-permanent body of knowledge (BOK) that grows up around a task, a person, or an organization.
- Second, tools that augment the BOK by bringing relevant data or expertise to people who need them when they need them.

Value-added knowledge work is rarely routine, because each sale, each project is unique. It is impossible to predict in advance what specific knowledge it will need.

The IC/IP knowledge base serves therefore a number of purposes that are important for knowledge management. For example, it is an index of the organization’s intellectual property – items such as patents, copyrights, design-rights, etc. This knowledge base will also contain information and analysis of the opportunities and challenges in the market place such as the major customer files and competitor intelligence. The IC/IP knowledge base is therefore primarily the repository of information and explicit knowledge about suppliers, customers, competitors, market trends, intellectual property about the particular industry, etc.

Discussion Knowledge Base

On-line discussion document bases are important repositories of more informal and unstructured information that accumulate while knowledge workers discuss certain pertinent topics amongst each other and with subject matter experts. For example, the issues of concern in a particular project are posed for comments, opinions, and experiences. Participants then add their opinions, comments, and solutions to this topic. These discussions typically are linked in a thread that combines the particular topic discussions. The threads are visually organized and displayed to emphasise relationships and sequence order of the discussions – a typical taxonomy of the discussions.

Although these databases have weak structure they are important as knowledge bases as many opinions of different expertise are accumulated. The management of this content is however more of an art than a science and needs further research.

Best Practices and Lessons-learned Knowledge Base

Teams can become more knowledgeable than the sum of their members. Interaction, conversations, dialogue, and interrelationships stimulate the thought processes and creation of ideas. Team learning can result from meetings on "***lessons learned***" or by solving complex problems as a team – overcoming individual assumptions and limitations as well as stimulating new thought processes and ideas.

As Nonaka pointed out in his knowledge-learning cycle, knowledge is created through interaction between tacit knowledge and explicit knowledge. The challenge is to expose the hidden knowledge and to share it with a team and the organization.

Knowledge is often intended to be explicit. Many organizations hold final project review meetings to learn from a project (including the positives and the negatives) to capture and distil the project's justification, existence, history, and results as well as "lessons learned". This is meant to assist in capturing and reusing the intellectual capital for future projects and engagements.

But, organizations often loose this opportunity because of time pressures, by underestimating the value of such actions, or just because the team is dismantled and redistributed making it difficult to recap the project's potential intellectual capital.

A best practice is therefore to capture experience in the lessons-learned knowledge base as a matter of practice and as part of all knowledge projects and procedures. In effect, the important issue here is to bank lessons learned – thereby creating checklists of what went right and what went wrong. This enables the development – on a continual basis – of guidelines for others undertaking similar projects. These guidelines can then be used to leverage what was learned so the knowledge workers can do the job better and faster the next time around.

Typical Knowledge Bases used by a Large Organization

We include here two references to case studies of how large organizations typically utilise knowledge bases: the cases of Booz Allen and Arthur Andersen of Denmark. All similar projects are ambitious attempts to organize scattered information and explicit knowledge, to convert it into organizational knowledge, and to make it easier to obtain colleagues' expertise and knowledge.

Booz Allen's Knowledge On-line (KOL)

Booz Allen developed their knowledge base called Knowledge On-line (KOL)[30]. KOL has been up and running since early 1995 and is supposed to save the consultants as knowledge workers from spending long and costly hours repeating each other's work. It was also designed to make it easy to tap the company's experts and ideas regardless of geography or speciality. For example, a knowledge worker may type a name and click on an icon "Experts/Resume/History" to find a resume of a particular colleague; or he/she may type "customer service" and the system will deliver a list of consultant names who know the particular customer service. Another icon is labelled "Knowledge." Behind it are a number of databases with thousands of documents, classified into topics such as marketing, reengineering, and change management. These documents can be accessed online and/or downloaded.
KOL also has bulletin boards, discussion forums, and training courses.

Business Consulting Practice at Arthur Andersen Denmark

The Business Consulting Practice at Arthur Anderson Denmark (AADk) used to be known for their progressive utilization of KM technologies[31]. AADk as a group were large users of Lotus Notes and based a number of their internal systems as well as systems for their customers on Lotus Notes. In parallel to Lotus Notes implementation they also aimed to give everyone within AADk a PC, a uniform set of tools and links to a common technology platform. They further focussed on space management in AADk's offices and, early on, developed a unique vision of the new office concept that included:

- Open offices – no boundaries; teams sit and work together in open spaces.
- Total mobility – No one has a pre-assigned desk or a fixed phone.
- Clean desks – desks have no drawers or storage areas; all work had to be filed away in the appropriate place at the end of the day.

[30] Sourced from: Stewart (1997)
[31] Sourced from: Dutta and de Meyer (2001)

- Easy access – professional staff would have all required support facilities within 10 meters of their desks.
- Electronic networking – all desks would have a networked PC / docking station.
- Single card access – one card would be used by all employees to access all functions such as security, restaurants, parking garage, and library.

The new office concept forced AADk to rethink the organization of archives and knowledge stores:

- The archiving process was redefined around the client.
- It offered flexible physical storage by client and was controlled by a Lotus Notes application.
- Electronic client folders were all done on Lotus Notes.
- Much of the material such as local and Arthur Anderson-wide manuals were moved on-line and updated centrally.

The result was enhanced team work and excellent knowledge sharing. Says Jarlbaek:

> "***Technological shifts such as the Internet and the global market space will require radical new ways of organizing knowledge and competing. . . . We believe that our people are our most valuable knowledge assets. Technology is now enabling us to create different kinds of knowledge assets – in real time and in virtual space!***"

The list of AADk's local knowledge bases is:

- Employee Policy Manual
- Computer Manual
- ISO Manuals (in line with ISO 9001)
- Private Addresses
- Telephone Directories – lists and short codes of the telephone system
- Client list

There were more than 50 different local knowledge-based applications in AADk in 2001. The following short list of these knowledge bases illustrates the type of knowledge bases that can be employed in such an organization.

<u>AA Knowledge Bases available online</u>:

AA On-line

This is a Lotus Notes application for internal communication world-wide, based on categories divided according to function and topic. Various forms of communication include the following:

- Publication of announcements (one to many)
- Conferences (closed, limited forum of users)
- Resources information (few to many)
- Discussions and Ask Arthur (many to many)

Global Best Practices

This is the result of centralized collection of basic data for auditing, methodological and procedural standards, and the systematic consolidation and analysis thereof for reporting global best practices and useful benchmark data.

3.4 Knowledge Harvesting Process

It is important to establish a culture of building the organizational knowledge collection, and of recycling experiences for the benefit of other members of communities and the whole organization[32]. Organizations that embark on a KM strategy typically provide a variety of KM services and organized networks to assist in the transfer process. Knowledge managers and knowledge integrators add value by scanning the flow of information, and "package" the knowledge in more applicable formats and representations. They also involve networks of people who come together to share and learn from one another face-to-face and electronically utilizing technology such as groupware.

It is however not a straightforward task. Motivation to contribute to the organizational knowledge is a key part of this process. Knowledge workers need to be rewarded for "valuable" contributions. This implies the existence of some judging and selection process with criteria for measuring the value of the content (positive of negative). Negative experiences from which to learn may be more valuable than the successful experiences. The contributions and their importance need to be recognised by peers and leadership.

This emphasises the importance of the "reflection" process inherent in organizational learning[33]. There are important lessons to learn and the harvesting process ensures that team members take the time to reflect on what they have learned and then share it with others.

Harvesting previous experience and best practices gained in engagements and with real business situations are beneficial to reduce time, effort and expenses for similar future situations. This is well articulated in the appropriate title of the book "***If only we knew what we know***"! (O'Dell and Grayson (1998)).

Organizations that actively employ KM as a strategy, typically assign specific knowledge transfer responsibilities to some staff members (as job descriptions or just as additional roles). These "change agents" are trained to assist other employees in:

[32] See for example O'Dell and Grayson (1998)
[33] As discussed in Part 1

- Finding, capturing, codifying, and transmitting knowledge and best practices to the corporate knowledge bases.
- Solving and improving processes by helping these emloyees to use the knowledge bases and other knowledge sources.
- Acting as internal consultants to facilitate implementation.

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In the next chapter we consider the aspects of knowledge creation and sensing.

Chapter 4 Knowledge Creation and Sensing

4.1 Introduction

In this chapter we consider the different aspects of knowledge creation and sensing in the KMTF model and the related KM technologies. As pointed out before, this category of the KMTF is the least supported by KM technology because most of its focus is on tacit knowledge and the human faculties of creating new knowledge and sensing the business needs for forming new knowledge. In the next two sections of this chapter, we discuss knowledge creation and the key KM technologies for this knowledge process, namely technologies associated with e-learning.

Because we still do not fully understand human intelligence and – for the lack of a better term, "accumulation of knowledge" – knowledge creation and sensing can typically be linked to the knowledge conversion patterns of "tacit-to-tacit" and "explicit-to-tacit" of Nonaka and Tacheuchi (1995). We describe these two patterns of knowledge conversion in the last two sections of this chapter.

4.2 Knowledge Creation

Individuals learn and grow their knowledge in a stimulating environment for knowledge creation. Individuals operate within teams and communities within the organizational structure and exploit organizational links to the external environment. This is especially true for knowledge workers.

Organizations create knowledge by creating infrastructure and processes that enable individuals and teams to share and improve new knowledge created by individuals. Learning can only be tested if insights are translated into actions that result in improved performance or in new/improved skills.

There are six points on knowledge creation to consider[34], namely:

1 Knowledge creation leads to continuous innovation, which leads to competitive advantage.
2 Knowledge creation takes place at three levels: the individual, the team or community, and the organization (as we discussed in Part 1).
3 Groupware creates opportunities for the sharing and spiralling of knowledge into the organization. (See chapter 5 for more detail on groupware.)

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[34] Adapted from Hongo and Stone (1997)

4 Learning involves knowledge, which leads to action. In order to act on new insights an individual must internalize it, contextualize it, and add own values and beliefs to it.
5 It is the interaction of tacit knowledge with explicit business problems that creates new knowledge.
6 Groupware can facilitate the reflection process only if the process of contributing to the system is well-managed and facilitated to ensure the quality of the contributions, and not just the quantity.

For competitive advantage the organization has to know more about crucial aspects of the business than its competition. To consistently know more implies that the knowledge workers have to learn from others; but they must also keep on generating new knowledge, evolve market know-how, develop new technologies, and grow understanding of customers and their needs.
There are therefore two types of learning in organizations, namely:

1. Receiving wisdom and generating new (tacit) insights.
2. Creating new (explicit) knowledge during the run of business

Creation of knowledge is the point at which individual learning and organizational learning come together. Most new knowledge is incremental. It is mediated more through invention than through true discovery. The former involves assembling known pieces of knowledge in new ways; the latter consists of finding ideas, approaches, and technologies that are truly revolutionary. Breakthrough ideas are important to value, but mostly it is the cumulative small incremental gains that are at least as valuable.

We discussed in Part 1 the necessity for knowledge workers to observe the way their colleagues go about their tasks, and the importance of this on-the-job training. As far as KM technologies in this regard are concerned, the primary technology for knowledge creation and sensing remains e-learning technology. This is the subject of our next section.

4.3 e-learning

Although many enterprises make little use of e-learning — discouraged by inadequacies in infrastructure or lack of course material and training support staff, etc. — e-learning represents a major opportunity to increase the rate and type of knowledge transfer and knowledge creation and sensing. It has long been used to support training, but e-learning can and should be different from and richer than just computer-based training (CBT). Learning involves interaction and simulation, so e-learning must address this challenge — otherwise; it risks simply becoming another unsuccessful self-serve training course. E-learning supports the development of intellectual assets, workplace collaboration and innovation.

In the knowledge workplace, it can be linked to personnel and organizational competency models, compensation plans, and reward schemes for contributions to the organizational knowledge base, as well as to innovative applications of the knowledge. As the knowledge workplace becomes more complex, end users are switched rapidly and ubiquitously between applications. To make this switching easy for end users, almost all KM applications offered by vendors provide just-in-time embedded e-learning capabilities. Embedded e-learning can eliminate the requirement to develop some individual competencies, thus reducing the risks of knowledge workplace competency/skill gaps and loss of experience (Logan (2001)).

Recently, much development has occurred in the area of Web-Based Instruction (WBI)[35]. WBI systems are engines developed to use the intranet or Internet capabilities to enable and support distance learning in an affordable, interactive and hypertext-linked way. The learner only needs a browser as technology. The system with the respective course content is kept either in the intranet server or in a generic Internet server. These systems typically are comprised of three distinct modules, namely:

- ***Authoring Module*** – used by the content's author to create the course.
- ***Utilization Module*** – used to process the training.
- ***Tracking Module*** – used by the course administrator to track and manage the performance of the pupils and the course as a whole.

Using a WBI system based on the intranet/Internet technologies and additionally exploiting video-conferencing and video-multicasting enables capabilities that allow just-in-time education, and an education anytime and anywhere. The utilization of groupware to assist in the communication and coordination enhances this process even further – assisting the whole KM process.

4.4 Two set of Technologies for the Knowledge Transfer Life Cycle

In the following we describe the set of knowledge management technologies in terms of two of the four steps of Nonaka and Takeuchi's organization learning cycle which we have described in Part 1 as the knowledge transfer cycle model. The two steps are the "tacit-to-tacit" and "explicit-to-tacit" phases. This is illustrated in Figure 17.

In Part 2, section 5.4.1 and 5.4.2 below, the two steps on the right side of the model are described, covering the role of technologies in support of the "tacit-to-explicit" and "explicit-to-explicit" phases of the organizational learning spiral.

[35] Sourced form sources such as: Joia (2001)

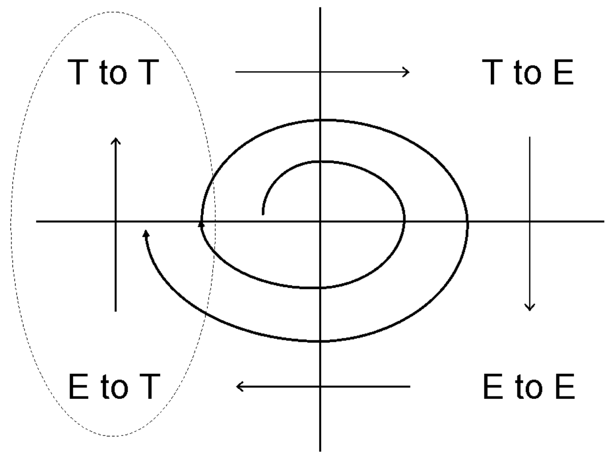

Figure 17: Concise knowledge transfer spiral model (left)

4.4.1 Tacit to Tacit

The typical way in which tacit knowledge is built and shared, is in face-to-face meetings and shared experiences, formal and informal, in which KM technologies play a minimal role. However, an increasing proportion of meetings and other interpersonal interactions use groupware as on-line tools. These tools are used either to supplement conventional meetings, or in some cases to replace them. One has to ask to what extent these tools can facilitate formulation and transfer of tacit knowledge. We cover some of these aspects below.

Groupware. As described in the previous section, groupware is a fairly broad category of application software that helps individuals to work together in groups or teams. Groupware can to some extent support all four of the facets of knowledge transformation. To examine the role of groupware in socialization we focus on two important aspects: shared experiences and trust.

Shared experiences are an important basis for the formation and sharing of tacit knowledge. Groupware provides a synthetic environment, often called a virtual space, within which participants can share certain kinds of experience; for example, they can conduct meetings, listen to presentations, have discussions, and share documents relevant to some task. Indeed, if a geographically dispersed team never meets face to face, the importance of shared experiences in virtual spaces is proportionally enhanced. The current market leader in groupware is Lotus Notes / Domino (Marwick (2001)). It facilitates the sharing of documents and discussions and allows various applications for sharing information and conducting asynchronous discussions to be built. Groupware might be thought to mainly facilitate the combination process, i.e. sharing of explicit knowledge. However, the selection and discussion of the explicit knowledge to some degree constitutes a shared experience.

A richer kind of shared experience can be provided by applications that support ***real-time on-line meetings*** — a more recent category of groupware. On-line meetings can include video and text-based conferencing, as well as synchronous communication and chat, also known as "live-collaboration". The recent emergence of Voice over IP (VoIP) technology – specifically the Skype technology – as a vehicle for conferencing constitutes a potential revolution in person-to-person communications. These technologies provide opportunities for relative cheap international communication. Text-based chat is believed to be capable of supporting a group of people in knowledge sharing in a conversational mode[36]. Commercial products of this type include Lotus Sametime (included in Lotus Domino) and Microsoft NetMeeting. These products integrate both instant messaging and on-line meeting capabilities. Instant messaging is found to have properties that lie somewhere between those of the personal meeting and the telephone; it is less intrusive than interrupting a person with a question in a personal meeting; but more effective than the telephone because it can broadcast a query to a group and leaving it to be answered later. In work on the Babble system[37], chat was evaluated by at least some users as being "… ***much more like conversation***," which is promising for the kind of dialogue in which tacit knowledge might be formed and made explicit. However, not all on-line meeting systems have the properties of face-to-face meetings. For example, the videoconferencing system studied by Fish et al (1993) was judged by its users to be more like a video telephone than like a face-to-face meeting. Currently, rather than replacing face-to-face meetings, many on-line meetings are found to complement existing collaboration systems and the well-established phone conference. They are therefore probably more suited to the exchange of explicit rather than tacit knowledge. On-line meetings extend phone conferences by allowing application screens to be viewed by the participants or by providing a shared whiteboard. An extension is for part of the meeting to take place in virtual reality with the participants represented by avatars. One research direction is to integrate on-line meetings with classic groupware-like applications that support document sharing and asynchronous discussion[38].

See also the discussion on electronic meeting systems on page 60.

Some of the limitations of groupware for tacit knowledge formation and sharing have been highlighted by recent work on the closely related issue of the **degree of trust** established among the participants[39]. It was found that videoconferencing (at high resolution — not Internet video) was almost as good as face-to-face meetings, whereas audio conferencing was less effective and text chat least so. These results suggest that a new generation of videoconferencing might be helpful in the socialization process, at least in so far as it facilitates the building of trust.

[36] See Marwick (2001).
[37] See Marwick (2001) who referenced the Babble system.
[38] An example is the IBM-Boeing TeamSpace project, which helps to manage both the artefacts of a project and the processes followed by the team. On-line meetings are recorded as artefacts and can be replayed within TeamSpace, thus allowing even individuals who were not present in the original meeting to share some aspects of the experience (Marwick (2001)).
[39] Marwick (2001)

Another approach to tacit knowledge sharing is for a system to find persons with common interests, who are candidates to join a community. In Foner's Yenta System[40], the similarity of the documents used by people allowed the system to infer that their interests were similar. Location of other people with similar interests is a function that can be added to personalization systems, the goal of which is to route incoming information to individuals interested in it. There are obvious privacy problems to overcome. (See also the related section covering expertise location, namely the section on "Expertise mapping and locating" on page 79.)

4.5.2 Explicit to Tacit

Acquiring and possessing tacit knowledge is a necessary precursor to taking constructive action and to making business decisions. This new tacit knowledge can be internalised through better appreciation and understanding of explicit knowledge. Technology to help knowledge workers form new tacit knowledge is therefore particularly important for knowledge management. A knowledge management system should offer information retrieval and also facilitate the understanding and use of information. For example, such a system can generate meta-data through document analysis and classification supporting rapid browsing and usage of available information. One can foresee that future information infrastructures will facilitate different modes of information usage such as search, exploration, classification, categorization, and finding associations (Marwick (2001)). Users can discover relationships between documents and related concepts and learn by exploring an information space. This will assist the knowledge worker to easier form new tacit knowledge.

When tacit knowledge is formed through learning rather than from exploring an information space a different set of technologies is applicable. Learning is increasingly done on-line bypassing typical classroom formats. On-line learning has the advantage of eliminating travel and of being compatible with modern tight work schedules. A wide variety of tools and applications support corporate distance learning. The trend toward self-directed learning rather than instructor-led learning has resulted in a focus on interactive Web-based courseware and on downloaded courseware applications. For example, one can assume that future generations of portals will offer modules for self-directed learning. (See also chapter 8 about KM portal technology for more detail.)

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In the next chapter we consider knowledge sharing and transfer.

[40] Referenced by Marwick (2001)

Chapter 5 Knowledge Sharing and Transfer

Successful knowledge transfer involves neither computers nor documents but rather interactions between people. – Davenport (1995)

5.1 Introduction and Background

In this chapter we address the KM technologies to support the knowledge process of knowledge sharing and transfer. We begin by considering the background that lead to the current set of KM technologies that are employed to facilitate this knowledge process. We position the different KM technologies in terms of the two dimensions of tasks to be performed in relation to the professionals performing them. This leads us to discuss the important concept of collaboration and KM (in section 5.2). This discussion includes a brief consideration of collaboration concepts (in section 5.2.1) and of groupware technology (in section 5.2.2). Section 5.3 then considers electronic meeting systems.

Because of the importance of the knowledge conversion concepts of Nonaka and Takeuchi (1995) we dedicate two sections to discussions on two of their identified steps in the organizational learning cycle, namely “tacit-to-explicit” and “explicit-to-explicit”. These sections refer to knowledge processes that belong in chapter 4 and we cross-reference these sections where applicable.

The early pioneers who tackled the challenges of using technology to manage knowledge (sometimes referred to as “unformatted information systems” (i.e. see (Botha, 1980)) built up considerable baseline experience in this area over a number of decades. In summary these include the following list[41]:

- Early generations of networking and computer technology offered improved access to knowledge online.
- Full-text document retrieval systems evolved into effective search technologies since the 1970s and 1980s (notably STAIRS, TRS, Medline, etc.); see (Botha, 1980).
- Collaboration solutions dated from the late 1970s / early 1980s and include first generation text processing, office-type e-mail, and document distribution (PROFS, DISOSS).
- On-line conferencing and discussion forums on centralized systems based on mainframe time-sharing technologies dated from the 1970s (notably based on VM/CMS and MVS/TSO).

An important set of technologies that existed as predecessors for the eventual knowledge management technologies of today were the ***<u>office systems</u>*** and the eventual ***<u>groupware</u>***

[41] Sourced from different sources such as Marwick (2001) as well as personal experience by the author

technologies of the 1980s and 1990s. Since the early 1990s Lotus Notes virtually defined knowledge management technology and has become the leading knowledge sharing and transfer technology that is available today. Many contemporary knowledge management solutions are based on Lotus Notes and its server component, Lotus Domino. It is a comprehensive integrated solution that includes many capabilities such as a knowledge base with content search, replication for disconnected / mobile usage, well advanced security, and application development tools. With its Lotus Domino Web server, content is also published and distributed on the Web. The native Web, however, is also offering a host of tools for KM that we will discuss[42].

Technologies have evolved from number-crunching abilities to primarily communication abilities. These capabilities enable people to work together in a collaborative and integrated environment that is well suited for knowledge sharing and transfer activities. These technologies support KM for example in the following ways[43]:

- They enable more than one person to work at the same time on the same document.
- They allow intelligent tracking of messages and documents within a process.
- They help employees to view and manipulate information simultaneously and efficiently.

The range of technologies that can accomplish these tasks is illustrated in Figure 18 (Joia (2001)). The two dimensions are chosen to represent a single task to several tasks on one axis as performed by a single professional or several professionals on the other axis. A single task performed by a professional requires systems for personal productivity such as office automation suites and personal information managers (PIMs). Where a professional executes multiple tasks he or she utilises integrated corporate systems such as enterprise resource planning systems (ERP) or other database systems.

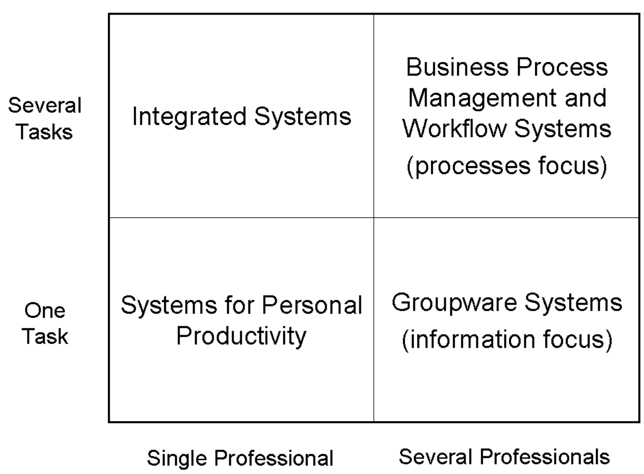

Figure 18: Systems positioning

[42] See Davenport and Prusak (2000), Firestone (2003), and others in this regard.
[43] See more detail in our coverage of CSCW and groupware later in this chapter.

The two cases where several professionals are performing typical knowledge work can be differentiated into systems that are focused on information – groupware systems – versus systems that have a process focus – business process management systems (BPM) and workflow systems.

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In the following three sections we cover collaboration and KM as a theme (including a discussion on groupware), electronic meeting systems, and technologies for the knowledge transfer life cycle.

5.2 Collaboration and Knowledge Management

KM programs must support collaboration between individuals and between communities. Doing business is a series of collaborative processes. It requires interaction among employees, vendors, suppliers, and business partners. Although e-mail is one example of an indispensable communication tool used by companies around the world, a number of other collaborative applications are increasingly coming into play. These solutions enable local work groups, or even geographically dispersed teams, to work together using real-time information sharing and distribution across the Internet.

The term “collaboration” can be used in many ways. We have found that many executives equated collaboration with e-mail. In commerce applications, it often refers to data sharing with no human dimension. In the context of KM, it is important to have a full appreciation of collaboration. The idea of linking together the knowledge held by discreet parts of the enterprise for greater collaboration and learning is now becoming a strategic focus of many organizations.

5.2.1 Collaboration Concepts

We identify two dimensions of collaboration, namely the mode and the scope:

1. The mode is determined (a) by whether the collaboration is based primarily around conversation or the exchange of messages (which includes e-mail as well as real-time discussion); or (b) is it based on creation and sharing of information in the form of documents and other persistent objects that are stored for reuse.
2. The scope is determined on whether the collaboration is interpersonal, or inter-enterprise, or something in between. Collaboration occurs at all levels of structure. KM, groupware and intranets have typically focused on collaborative processes inside an enterprise. Increasingly, they are following e-mail in recognizing a scope extending beyond the enterprise.

Various terms such as group support systems (GSS), computer supported co-operative work (CSCW), and groupware have been used to describe the area that studies workgroup computing and its implications. The intent of this business tool set is to coordinate and collaborate via effective communication that links people as knowledge workers to business processes and information.

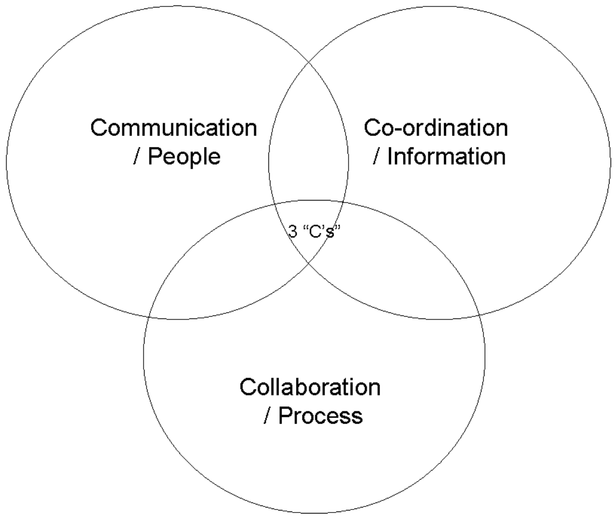

Figure 19: The 3 "C’s" links People to Process to Information

Groupware is thus the technology that implements workgroup computing. Conceptually workgroup automation is best characterised by its three “Cs” namely: ***“Communication, Collaboration, and Coordination“*** as is conceptually illustrated in Figure 19.

The 3 “C’s” seen from a technology perspective can be illustrated as examples in Table 3.

People Connections	Electronic mail
	Fax
	Conferencing
	Shared folders
	WWW
Process	Workflow
	Calendar / Time Management
	Development Environment
Information	Database links
	Document Management
	Forms
	Filters / Search Engines
	Security

Table 3: Connecting People, Process, and Information

5.2.2 Groupware

Important ***groupware*** technologies include: The intranet / Internet-based applications such as e-mail, bulletin boards, newsgroups, chat, and video-conferencing. The latter is becoming important for sharing tacit knowledge because of its “face-to-face” or “person-to-person” characteristics. Other technologies in this regard include distributed databases and electronic data exchange technologies such as XML.

Groupware is a combination of technologies enabling an organization to create, share, and leverage an accumulated knowledge base. Groupware technologies include electronic mail (e-mail), instant messaging, group calendaring and scheduling, shared document libraries, discussion databases, and news groups. Groupware technologies dramatically reduce the time and effort necessary to distribute ideas, notifications, proposals, and documents throughout workgroups and communities.

E-mail has promoted information sharing. Shared calendaring and scheduling applications enable coordination of activities without the burden of personally contacting each participant multiple times to verify open dates and confirm attendance. Likewise, workflow, imaging, and electronic forms (e-forms) increase the rate at which information can be entered and retrieved by individuals or groups, thus enabling better productivity and sharing of information. New multi-media technologies are emerging for real-time collaboration using PCs, cameras, teleconferencing, etc.

Currently, groupware technologies are implemented within individual organizations. Since each organization selects its own groupware technologies, frequently hardware, software, and file formats are not compatible with those of other organizations. Incompatible implementations create barriers to enterprise-wide collaboration, inhibit interoperability between systems, and increase the cost of system support.

For an enterprise-wide groupware implementation to succeed, the comprised technologies must comply to a set of common protocols and infrastructure standards, allowing them to communicate with one another. Some groupware technologies, such as e-mail, have made considerable progress in the standardization of protocols across software products. Other groupware technologies are fast maturing but have not yet standardized on protocols.

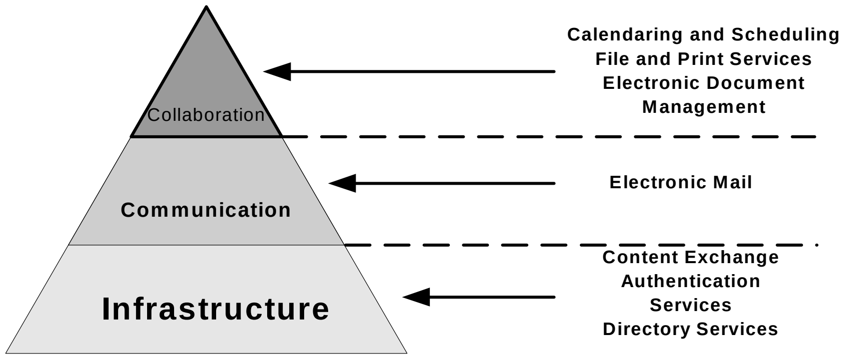

Figure 20: Areas of Groupware

Since the goal of groupware is to foster collaboration and communication, certain areas require more standards adherence than others. For example, it is more important to establish standards for communication rather than collaboration, since the impact is broader. Figure 20 illustrates the related groupware areas:

- **Infrastructure.** The foundation required to enable communication and collaboration across an organization. Infrastructure includes content exchange, authentication services, and directory services.
- **Communication.** The process of delivering information on intranets, extranets, and the Internet. Electronic mail (e-mail) is the primary backbone for communication.
- **Collaboration.** The flow of work and business information within an organization or an ad hoc workgroup. Automated collaborative applications include calendaring and scheduling, file and print services, and electronic document management.

Groupware technologies should overcome time and distance barriers

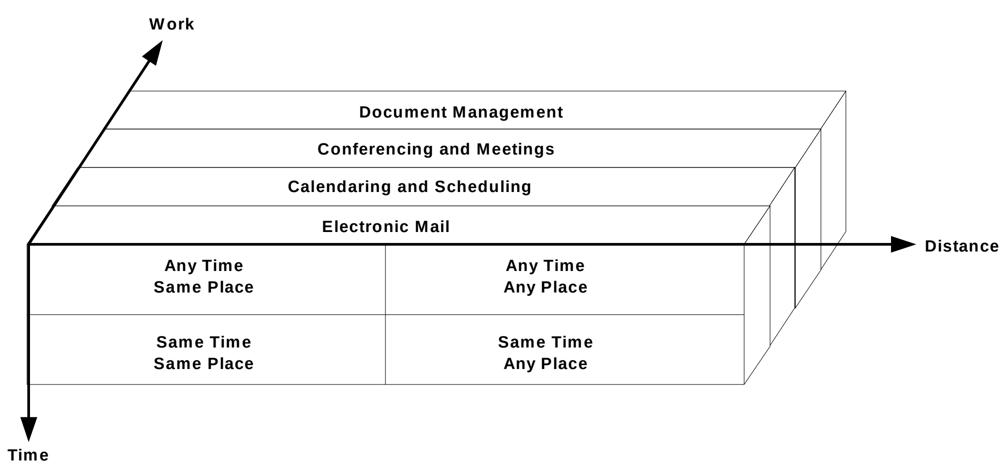

Figure 21: Time and Distance Barriers

Figure 21 illustrates time and distance barriers of groupware while Figure 22 lists some examples of the applicable technologies[44].

- Groupware technologies must encompass all scenarios from working the same time at the same place to working any time from any place.
- Geographical boundaries are eliminated by groupware technologies, providing communication and real-time access to information from any location.
- The efficiency and quality of a process are partially measured by the timeliness with which the work is performed. In order to determine whether groupware is providing value to a process, the notion of timeliness must be qualified for that process. For example, a month may be considered acceptable for passing a specific group of documents through an organization for approval. In contrast, a month to send e-mail to that same group of people is unacceptable.

	Same Place	Any Place
Any Time	Support for shift work, etc	e-mail, etc.
Same Time	Meeting support, etc.	Video conferencing, etc.

Figure 22: Collaboration technologies for time and place

5.3 Electronic Meeting Systems

> ***Meetings are occasions where the minutes are kept but the hours are lost.*** – Anon
> ***A meeting is a gathering where people speak up, say nothing, and then all disagree."*** – Kayser

An electronic meeting system (EMS) is another groupware tool for reflective learning and information sharing. Typically the average corporate "meeting" is not well-structured and chaired. The typical knowledge worker resents meetings and regards them as a time-waster.

[44] Derived from many sources; see also Wiberg and Ljungberg (2001) and Coleman and Khanna (1995).

There are many reasons why people meet when they are working together[45]: to share information, to make decisions, to avoid decisions, to socialize, etc. Many things can go wrong with a meeting. Participants may lack focus, or may be focused on hidden agendas. Some people may be afraid to speak up, while others may dominate the discussion. Meetings are difficult and also expensive. Nunamaker et al (1995) calculated that about 11 million formal meetings happen per day in the USA consuming between 30% and 80% of a manager's day. However, meetings will remain essential and valuable for doing business because knowledge workers have to share and exchange knowledge in addition to their other tasks.

Using an EMS the typical meeting and group gathering can be changed fundamentally (Nunamaker et al (1995)). An EMS is a collection of computer-based tools, each of which can structure and focus the thinking of team members in some unique way. For example, an ***electronic brainstorming tool*** encourages a group to diverge from standard patterns of thinking to generate as many ideas as possible. All users type their ideas into the system simultaneously. The system randomly passes ideas from one person to the next. The participants can argue with or expand on the ideas they see, or can be inspired to a completely different line of thought. In contrast, a tool called an ***idea organizer*** encourages a group to converge quickly on key issues and explore them in depth. ***Electronic voting tools*** can uncover patterns of consensus, and focus group discussion on pattern of disagreement[46].

Therefore, an EMS helps to break down communication and personality barriers; it helps to create a safer and more participating environment for knowledge sharing and idea generation. First generation EMSs were purely for "same place, same time" situations with limited functions for ways to put the outcome of the meeting online and to put it to use. Putting it online enables continuing additions and comments to the outcome. Today, most EMSs have capability to export the knowledge created during the group session into other groupware tools or to publish it on a Web server for future use. Modern EMSs offer functionality for teams to have not only "same time, same place" but also "anytime, anyplace" meetings and idea creation activities.

See also the discussion on the shared experiences described in context of the tacit-to-tacit knowledge conversion on page 51.

45 Sourced from sources such as Nunamaker et al (1995)
46 There exist many tools related to this. For example: see lists of these in Nunamaker et al (1995).

5.4 Two sets of Technologies for the Knowledge Transfer Life Cycle

In the following we describe the set of knowledge management technologies in terms of two of the four steps of Nonaka and Takeuchi's organization learning cycle – or more correctly organization learning spiral – which we have described in Part 1 as the knowledge transfer cycle model. This is illustrated in Figure 23.

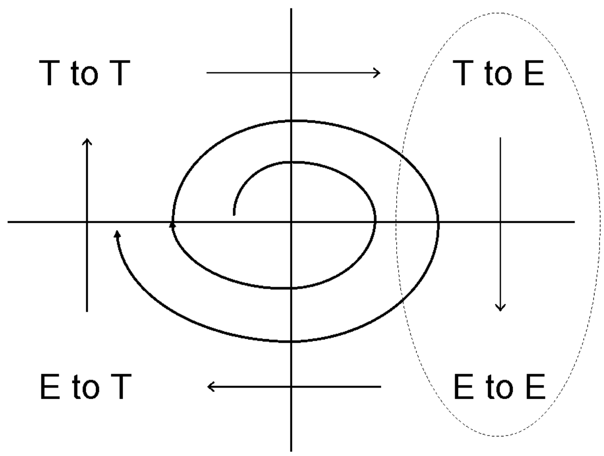

Figure 23: Concise knowledge transfer spiral model (right)

Knowledge Conversion	Tacit	Explicit
Tacit	Socialization Sharing Meetings and discussions Chat rooms / synch. collaboration Informal e-mail Conferencing tools e-meetings Synchronous collaboration (chat)	Externalization Articulation; Capturing Write a report Authoring tools Collaborative filtering Capture information in course of work Answering questions Annotation
Explicit	Internalization Learning Learn from a report Summarization, navigation Detect & visualize relationships Personalize task & context Visualization Browsable video/audio presentations	Combination Copying; Distributing e-mail a report Current awareness - subscription Content maps for Knowledge browsing Organize or classify content or people Advanced text search Document categorization

Table 4: Knowledge conversion life cycle

In Part 2, section 4.4.1 and 4.4.2 above, the two steps on the left side of the model have already been described, where the role of groupware, online learning, etc. were noted as technologies in support of the "tacit-to-tacit" and "explicit-to-tacit" phases of the organizational learning spiral.

Reproduced from Part 1 is Table 4 that summarizes many of the aspects and technologies of the knowledge conversion life cycle.

"***The individual technologies [in the table] are not in themselves knowledge management solutions. Instead, when brought to market they are typically embedded in a smaller number of solutions packages, each of which is designed to be adaptable to solve a range of business problems. Examples are portals, collaboration software, and distance learning software. Each of these can and does include several different technologies***." (Marwick (2001))

In the following two sections we describe the right hand side of the relations of this model[47], emphasising the technologies that support these steps.

5.4.1 Tacit to Explicit

According to Nonaka, the conversion of tacit to explicit knowledge (externalization) involves forming a shared mental model, then articulating through dialog. Collaboration systems and other groupware (for example, specialized brainstorming applications (Nunamaker et al (1995)) can support this kind of interaction to some extent.

On-line **discussion databases** are another potential tool to capture tacit knowledge and to apply it to immediate problems. We have already noted that team members may share knowledge in groupware applications. To be most effective for externalization, the discussion should be such as to allow the formulation and sharing of metaphors and analogies, which probably requires a fairly informal and even freewheeling style. This style is more likely to be found in chat and other real-time interactions within teams. See in this regard also the section that covers discussion knowledge bases on page 41.

Newsgroups and similar forums are open to all, unlike typical team discussions, and share some of the same characteristics in that questions can be posed and answered, but differ in that the participants are typically strangers. Nevertheless, it is found that many people who participate in newsgroups are willing to offer advice and assistance, presumably driven by a mixture of motivations including altruism, a wish to be seen as an expert, and the thanks and positive feedback contributed by the people they have helped.

Within organizations, few of the problems experienced on Internet newsgroups are found, such as flaming, personal abuse, and irrelevant postings. IBM's experience in this regard is described by

[47] Sourced form many sources; these sections are mostly from Marwick (2001)

Foulger (1991)[48]. For example a typical exchange in an internal company forum illustrates how open discussion group experts are used to contribute knowledge in response to a request for help. The archive of the forum becomes a repository of useful knowledge. Although the exchange is superficially one of purely explicit knowledge, the expert must first make a judgment as to the nature of the problem and then as to the most likely solution, both of which bring his or her tacit knowledge into play. Once the knowledge is made explicit, persons with similar problems can find the solution by consulting the archive. A quantitative study in the IBM system quoted by Marwick (2001) showed that the great majority of interchanges were of this question-and-answer pattern, and that, even though a large fraction of questions were answered by just a few persons, an equal proportion were answered by persons who only answered one or two questions. Thus the conferencing facility enabled knowledge to be elicited from the broad community as well as from a few experts.

5.4.2 Explicit to Explicit

As stated by Marwick (2001):

> "***There can be little doubt that the phase of knowledge transformation best supported by IT is combination, because it deals with explicit knowledge. We can distinguish the challenges of knowledge management from those of information management by bearing in mind that in knowledge management the conversion of explicit knowledge from and to tacit knowledge is always involved. This leads us to emphasize new factors as challenges that technology may be able to address."***

Capturing knowledge. Explicit knowledge is the result of tacit knowledge being conceptualized and articulated. This needs to be captured in a persistent form such as in an e-mail, report, a diagram, a presentation, or published as a Web page. This captured knowledge can then be distributed to or stored for access by the rest of the organization. Most current documents are produced by technologies such as word processing which automatically contribute to knowledge capture. These electronic documents are easy to share and distribute via technologies such as the Web, e-mail, or document management systems. This makes explicit knowledge available to a wide group of knowledge workers. The goal of most knowledge management projects is to improve knowledge capture – deriving and controlling knowledge from experts and explicit knowledge sources.

A problem that needs to be addressed is to motivate the human contributors to the knowledge capture process. As a motivation, authors of documents can be rewarded for the quality of their contributions. The ideal is to automate this process as far as possible and reduce resistance by employing technology to reduce any barriers to generate shareable electronic documents.

[48] Quoted by Marwick (2001) – no reference recorded

Barriers may include, for example, requirements for authors to fill in additional forms. Many approaches may be taken to this effect. We discuss two of those in the following.

The first promising approach is to automate the use of documents and measure the usage patterns and behaviour. In doing so, estimates of usefulness and quality can be calculated per document and authors can be rewarded accordingly. Current technology is still evolving towards this ideal[49].

The other approach to measure quality is to measure the number of times a document is cited in published documentation or is referenced as a hyperlink on the Internet. A citation or hyperlink is evidence that the author who cites or links to the document regards the target document as valuable. Analysing the links on Web pages indicates the cumulative value judgements on documents. This is most valuable in ranking document value and deriving quality estimates. This technique is used very effectively in information retrieval to rank the documents in the search results list. This technique is used in Web searching by the well-known Google search engine (Brin and Page (1998)). Marwick (2001) states:

> ***"Citation analysis of this kind detects quality assessments made in the course of authoring documents. Quality judgments by experts are another way to capture their knowledge. There are, of course, many deployed solutions in which documents undergo a quality review through a refereeing process, often facilitated by a workflow application."***

By far the most common way of capturing knowledge is to write a document. Other forms of media such as digital audio and video recordings are becoming easy to use, and an expert may find it easier and more convenient to speak to a recording camera or microphone than to write. It is also very easy to distribute such captured knowledge on current networks. The disadvantage of these media is that it is more difficult to search than text documents and thus less useful as material in knowledge repositories. Technologies for browsing video material is improving. They are based on summarization techniques that can extract themes as a gallery of extracted still images – each representing a significant part of the video. See for example Lienhart et al (1997) and He at al (1999).

A number of video searching systems are now available that use image searching of extracted frames. See for example Retrievalware (www.excalibur.com).
Composing a meaningful image query with these systems is usually difficult. Some systems extract text from the multimedia objects, if possible (for example Retrievalware). Some video may contain text, but "in most cases the challenge is to convert speech to text" which we refer to next.

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[49] See for example: R. Copeland, ***Mine Your Intellectual Assets***, www.InformationWeek.com specifically at http://www.informationweek.com/824/lotus.htm (2001).

Speech recognition. Recently big improvements occurred in the accuracy of automated speech recognition (ASR). The aim is to have usable speaker-independent recognition with unconstrained vocabulary in the medium term. Accuracy for speech recorded under controlled conditions is already acceptable and this will lead to new ways to capture knowledge, Marwick (2001).

Search. The most basic task for the handling of explicit knowledge is searching. Most organizations make all their electronic documents available on-line. The volume of these repositories grows fast and becomes very large. The challenge of on-line access to documents is thus transformed into the challenge of finding documents relevant for a particular task. The potential relevant information is located in a diverse number of sites such as local intranets, the Internet, and from commercial on-line publishers. The use of search technologies has increased hugely in the last decade as most knowledge workers have become more dependent on finding information to complete their tasks.

See Chapter 6 on page 68 that covers Searching and Indexing.

Taxonomies and document classification. Domain knowledge can often be represented as a "knowledge map" or "taxonomy" – a hierarchical organized set of categories[50]. A typical taxonomy includes several different kinds of relations. The value of a taxonomy is twofold:

1. It allows a user to navigate to documents of interest without having to search.
2. A knowledge map allows documents to be put into context thus helping users to value the applicability of these documents for the specific task.

It requires significant effort and cost to assign categories manually to documents. Recently automatic document classification has advanced to the point where accuracy of the best algorithms exceeds 85% on good quality data. This is adequate for many applications for specific data types and compares very well with the best manual classification. (Results vary widely when different data types are considered.) The current generation of automatic classification includes algorithms for machine learning that train themselves from sample data (Marwick, 2001).

There are many <u>challenges</u> in implementing solutions that use taxonomies. The first challenge is the design of the taxonomy which should balance comprehensibility for the users (requiring minimal training) with usefulness by describing the domain in enough detail. A number of strategies exist for building taxonomies including the use of document clustering to derive candidate subcategories (Pohs et al (2001)). In the majority of cases, human input is required to ensure that the taxonomy reflects the application domain needs.

Taxonomies have become very popular as a way in which to build a domain model to assist users to navigate and search. It seems to be a trend that user groups of various sizes each have their

[50] See coverage of taxonomy in the section "Taxonomy and Ontology" on page 35.

own taxonomy. This is quite natural, as users want to see information displayed in terms of a domain model that represents their own priorities and terminology. Marwick (2001) states:

> "***This trend is likely to lead to a proliferation of taxonomies in knowledge management applications. It follows that there will be an increasing focus on the need to map from one taxonomy to another so as to bridge between the schemas used by different groups within an organization***".

Portals and meta-data. Portal technology provides convenient meta-data about documents in their domain. See Chapter 8 on page 82 for more detail.

Summarization. A document summary is a kind of meta-data that reflects a short view of the whole document and enables users to quickly sift out documents relevant to a particular task. Automatic generation of summaries is being actively researched. (See more detail in chapter 6.)

We cover this area of searching technologies in more detail later in this study; see the part on the applications of knowledge management (Chapter 7 on page 77) as well as the section "Search, Indexing, and Retrieval" on page 72.

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In the next chapter we briefly cover the aspect of searching and information retrieval.

Chapter 6 Advanced Search, Indexing, and Retrieval

... ***you shall seek all day ere you find them; and, when you have found them, they are not worth the search***. – William Shakespeare, "The Merchant or Venice"

6.1 Introduction and Background

In this chapter we make brief remarks about searching, indexing and retrieval that are relevant to KM. This is an important topic for KM but also a discipline in its own right, having been studied for decades[51]. Recently some interest is being shown in the overlap between the information retrieval discipline, library science, and KM; see for example Koenig (2005) where the author has surveyed the opportunity offered by KM for library science.

In this chapter we discuss the phenomenon of information overload followed by remarks about information retrieval in relation to KM. We also cover the important aspects of information and knowledge filtering as well as linking.

Most information is currently produced online. Examples are: correspondence, e-mail, travel reports, customer contacts, administrative manuals, contracts, plans, etc. The text retrieval solutions now available can enable users to avoid recreating information or making decisions without the relevant information created by unseen collaborators. The information overload alluded to in the following section makes it inconceivable for most organizations to search their document bases manually. Therefore, one has to consider the electronic document in all its formats and media as the key unit for search and retrieval.

Traditional Information Retrieval

Research on and commercialization of information retrieval, have produced quite sophisticated retrieval techniques for a substantial time period. However, these systems continue to be limited by the semantics for retrieval. They typically process every word in a document, deleting common words (stop words), reducing words to the root form (stemming), and creating a rich-text index which also includes the structured data related to the document. The latter includes information elements such as the title, author, abstract, creation date, and other bibliographic information of the document. Sophisticated retrieval techniques have been added that measure word occurrences to make the (statistical) meaning of search terms more specific. These techniques are complemented by synonym dictionaries and thesauri that provide words with meaning. More

[51] See for example Botha (1980, 1991, 1992, and 1995), Salton (1989), and Baeza-Yates et al (1999).

advanced approaches utilize special concepts consisting of weighted values of search terms (See for example: Botha (1995), Coleman and Khanna (1995)).

Therefore, traditionally, text databases are indexed on the basis of keywords and characteristics such as proximity and occurrence frequency in the text. Typical implementations utilize inverted file indexing representation techniques. Keyword occurrence and (statistically) positioning in documents are relatively shallow aspects of knowledge. Search queries of this nature are not sophisticated enough to extract knowledge in any significant way. Further, this approach is not applicable for non-text documents. Various techniques have been proposed to address this problem. There are three techniques for information retrieval that produce more effective document representation than the inverted files techniques just discussed. They are: fuzzy search, dictionary augmentation, and multi-dimensional spaces. These techniques have been employed with varying degrees of success, but will not be further discussed here. For more information on these themes, the reader is referred to references such as: Salton (1989) and Baeza-Yates et al (1999).

But, a major challenge for search and information retrieval as well as for KM, is the phenomenon of the information overload. That is the topic of the next section.

6.2 Information Overload

Present day organizations experience a huge overload of information (the so-called “information explosion”). This in itself motivates the adoption of new technology to assist in the comprehension of explicit knowledge. In order to make informed decisions, knowledge workers are challenged to not only integrate the large amounts of information available but to locate it in the first place, from many sources and different locations. Information overload occurs when the quality of decisions is reduced because the decision maker spends time reviewing redundant information instead of making decisions.

Daconta et al (2003) have calculated the document storage capacity on a typical PC (using a 60- to 80-GB drive, plaintext, and 3500 characters per page) to be around 17 to 22 million pages of information. It is clear from these figures that we are only actively managing a small fraction of the total information we produce.

The World Wide Web has dramatically changed the availability of electronically accessible information. Daconta et al (2003) contend that the Web currently contains more than 3 billion static documents, which are accessed by over 500 million users internationally. Other authors judge the number of pages on the Web as double this, namely at more than 6 billion pages (see www.liquidinformation.org) because the well-known Google search engine indexes more than 6 billion pages[52]. Internet search engines have barely even catalogued 1/6th of the total information available and Internet traffic is doubling every 100 days according to Interactive Week. Wurman (referenced in www.liquidinformation.com), puts it aptly: "***everyone spoke of an information overload, but what there was in fact was a non-information overload***".

Growth in Global Volume of Knowledge

The written volume of information/knowledge started since 1447 with the invention by Johann Gutenberg of the printing press. After about 300 years – by about 1750 – the global volume of information/knowledge had doubled. It doubled again by about 1900 and redoubled by 1950! The present rate of growth is estimated to be a doubling of the global volume of information/knowledge every 5 years. Provided that this growth is sustained, some believe that by 2020 information/knowledge may even be doubling every 72 days (Dutta and de Meyer (2001))! The point to be made here is, that these estimates are projecting a staggering volume and growth of information/knowledge that are important for KM.

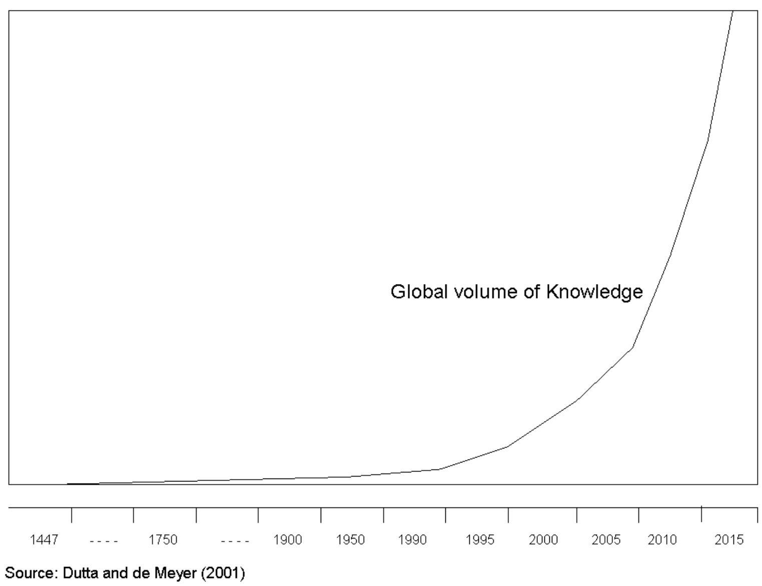

Figure 24: Growth in Global Volume of Knowledge

One should note that in addition to the familiar text-based information this volume will also consist of information and knowledge, produced and kept in media such as sound, images, animation, film and virtual reality simulation. This fast growth in the volume of available knowledge is illustrated in Figure 24 while Figure 25 illustrates estimates of the real (enormous) values that this information overload represents[53]. We included useful tables named: "What is Volume?" in the appendices.

[52] The researchers at www.liquidinformation.org quote the following staggering figures: "***More information has been produced in the last 30 years than in the previous 5,000. About 1,000 books are published internationally every day, and the total of all printed knowledge doubles every eight years,***" according to Peter Large in Information Anxiety.

[53] Figures and examples sourced from Dutta and de Meyer (2001) and IBM publications

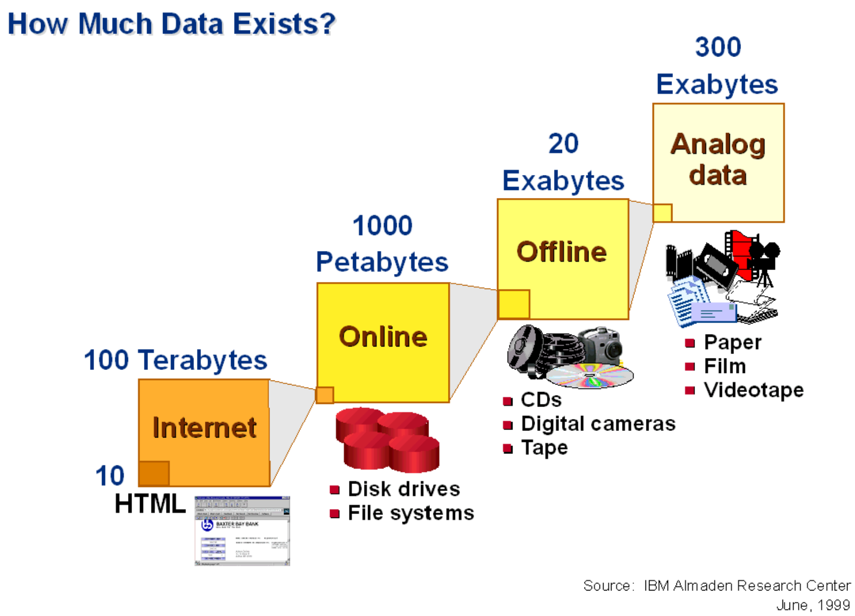

Figure 25: Examples of the values in the information overload

The Challenge for Information Retrieval

At the same time, this enormous amount of information has made it increasingly difficult to find, access, present, and maintain relevant information. This is because information content is presented primarily in natural language textual format. Thus, a wide gap has emerged between the information available for tools aimed at addressing these problems and the information maintained in human-readable form.

Various approaches can be taken to technically assist in handling the information overload. Redundant information and repetition can be reduced by eliminating duplicate and similar documents. Messages can be filtered and prioritized, or compound views can ease sifting through and comprehending the retrieved information. Using visualization techniques is an alternative and powerful approach to help the user better understands the available information.

This information explosion is challenging the ability of all companies to make constant adjustments. This may result in information chaos. It forces companies to realize the importance of controlling the information by means such as filtering, structuring, categorizing, and validation of the information sources. This affects the decision making process within companies with regard to selecting the right information to perform actions, procedures, decision support, etc.

6.3 Search, Indexing, and Retrieval

KM requires a complex suite of tools to capture the information, store it, and allow widely available access. This is particularly true for search and retrieval of unstructured, document-based information / knowledge. At a minimum the requirements will include Hypertext Mark-up Language (HTML) publishing tools for producing Web-type documents and/or preferably the ability to at least distribute knowledge in XML format and with XML's extensions to incorporate taxonomies and even an ontology.

Also required is a relational database (for storing these documents in XML-based format), text search-and-retrieval engines, and some approach to managing "***meta-knowledge***" that describes and facilitates access to the available information / knowledge.

Another requirement for search and retrieval in knowledge management is the development of an ***on-line thesaurus*** or at least ***more semantic assistance***. (See section 3.3.3 on page 30.)

"***Today intranets and the Internet are ubiquitous, and we are rapidly approaching the situation where all the written information needed by a person to do his or her job is available on-line. However, that is not to say that it can be used effectively with the tools currently available***." (Marwick, 2001)

There is, however, little standardization in terms of search user interfaces, different search language conventions, and different ways to present the result lists. Portal technology – as described in chapter 8 – is an approach to reduce the complexity of the knowledge worker's task. The portal technology maintains its own meta-data about the information available to the knowledge worker. Currently this meta-data is quite simple, being a list of sources and a search index built from the content of those sources. This feature greatly improves productivity because the user does not have to visit all those sources for relevant information. Most portal systems use a single index. This requires that the documents in those sources have to be indexed via so-called "spidering" or "crawling". Distributed indexes or federated indexes have failed to become popular but recent advances may change that state of affairs[54].

In traditional information retrieval, the index of the search engine contains a list of the words that occur in the indexed documents. This is augmented by an inverted file data structure which allows the documents in which those words occur to be efficiently retrieved at search time. See detail discussed in Botha (1992), Botha (1995), and Baeza-Yates et al (1999). Researchers use a query language that contains words they think will be contained in the documents. Users face the problem that different words are used in different documents to express similar meaning.

[54] See for example Web references covering the peer-to-peer applications such as "Gnutella" and the collaboration application "Groove".

Therefore not all the documents that refer to a particular concept are retrieved. Different approaches to counter this problem when high recall is expected have been developed over a number of decades (see Botha (1980) for a number of early alternatives). Amongst these is a controlled vocabulary which is effective when the researchers are trained users such as librarians. But, for the typical knowledge worker, the evidence is strong that searching with natural language gives better results than using a controlled vocabulary; see for example Botha (1992).

The most common problem in document searching is that a query retrieves many irrelevant documents that do not address the user's needs. This is known as the problem of search precision (which is a measure of retrieval accuracy)[55]. With the tremendous growth in available information – see also for example Shenk (1997) – precision becomes highly important. Recent research indicates however that the accuracy of natural language search engines has reached a plateau in recent years (Marwick (2001)).

The two areas that promise to improve the status quo are: "***increased knowledge of the user and of the context of his or her information need, and improved knowledge of the domain being searched***" (Marwick (2001) and Botha (1992)). We realise that the only information about the user's needs that is known to the system is contained in the user's query. Research regarding queries submitted on the Web has found that the most common query consists of two words and the average query length is 2.3 words (Spink et al (2001)). This is obviously very little information about the user's context and needs. Advanced searching techniques are thus required to gather improved information about the context of the search. This is a challenging research area which is aimed at building advanced search engines that can exploit this context knowledge along with the submitted query.

Much more advanced, is the area of gathering and using more information about the domain in which the search is conducted. Yet, limited progress has been realised. For a number of decades the most prominent technology to tackle this challenge is to employ a thesaurus in the search process (Botha (1980)). A thesaurus is a language assist tool for searching. In a way it is a kind of simple domain model (as stated before: a more advanced taxonomy). The thesaurus is utilized by expanding the query with synonyms and other relations from the thesaurus. This approach is known to improve the recall in a text search. The expansion is effective provided the domain is well-defined with low ambiguity of words and when the validity of term relationships is less important. In broad domain searching, the precision may be improved by using thesauri as well as more advanced structures such as an ontology. Yet, a number of mixed negative and positive results were published and research in this area is ongoing. See for example (Baeza-Yates et al (1999)) which reports some positive results.

[55] See Botha (1980) for detail such as the definitions and the relationship between the concepts of "precision" and "recall".

Woods et al (2000) have used a different approach to encode the domain knowledge. They used a semantic network that integrated syntactic, semantic, and morphological relationships. Mack et al (2001) also point to prompted query refinement, relevance feedback, and sophisticated ranking techniques as additional techniques in this regard.

Of high importance for KM are the new developments that incorporate semantic information, XML and ontologies as we describe next.

6.4 Search and Retrieval using Web Services and Ontologies[56]

We have covered aspects of Web services and semantic considerations in section 3.3.3 on page 30. The most promising architecture for building systems for KM in the medium term is likely to be based on Web services and will incorporate semantic rich environments for search and retrieval including ontologies.

Because data is stored in an easily accessible (Web services) format and is associated with ontologies and taxonomies, retrieval of information / knowledge is more powerful and easier than not having the advantages that result from employing more semantic rich support tools. Because all information in such an environment – with Web services and the semantic web – is linked with an ontology and taxonomy, searches will provide results that otherwise would be unseen.

The search and retrieval process specifically in the context of Web services and the Semantic Web offers opportunities for providing important functionality which we describe next:

Discovery of knowledge via taxonomies. Because each Web service can be classified in various taxonomies, taxonomic searches can be done across the Web services of an organization. A good example would be, "I'm looking for all Web services classified in the corporate taxonomy as related to Coal Mining." (Daconta et al (2003))

Web service-based data searches. Using standard SOAP interfaces, any application can query Web services in the enterprise.

Search by association. Because the data is mapped into an ontology, semantic searches can be made across the entire knowledge base. We have traditionally left associations out of the search equation. This is a powerful extension to previous approaches and a direct KM benefit of the Semantic Web. A good example of such a search would be, "***I would like to perform a query on all relatives of my father, their closest friends, and their closest friends' friends***." In an electronic commerce application, associations offer additional buying opportunities to customers. For

56 Sourced from Daconta et al (2003)

example, if a potential customer searches for a particular machine or commodity, once that product's representation is found in the ontology, its associations can be selectively displayed as related equipment, components, and services.

Pattern-based searches. Because all data can be semantically linked by relationships in the ontology, patterns that would not have been seen in the past – by old data mining techniques that did not directly utilize meaning – can now be dynamically found with semantic searches. An example of such a search would be, "***Of all grocery stores listed in our corporate ontology, which stores have had revenue growth combined with an increased demand for orange juice?"*** (See also chapter 9.)

Manual and agent-based searches. Although all of the searches can be manual, software agents can be equipped with rules to continually search the knowledge base and provide you with up-to-the-second results and alerts. An example of such an agent rule-based query would be, "***Alert me via SMS / email whenever a new document is registered discussing a new computer virus***."

Rule-based orchestration queries. Because Web services can be combined to provide modular functionality, rules can be used in order to combine various searches from different Web services to perform complicated tasks. An example of such a query would be, "***Find me the lead engineer of the top-performing project in the company. Based on his favourite vacation spot from his response in the Human Resources survey, book him two tickets to that location next week, grant him vacation time, and cancel all of his work-related appointments.***"

Automated inference support. Because the corporate ontology explicitly represents concepts and their relationships in a logical and machine-interpretable form, automated inference over the ontology and its knowledge bases becomes possible. Given a specific query, an ontology-based inference engine can perform deduction and other forms of automated reasoning to generate the possible implications of the query, thus returning much more meaningful results. In addition, of course, the inference engine may discover inconsistencies or even contradictions in the ontology or knowledge bases. As the corporate ontology and the knowledge bases it spans are elaborated over time, more complicated automated reasoning can be performed (for example, induction of new knowledge based on old knowledge, and the incorporation of probabilistic techniques). This automated inference itself can be considered a Web service or set of Web services, and can be utilized by software agents or human users.

6.5 Information and Knowledge Filtering

Because of the information overload, a number of authors have alluded to the importance of being able to determine which items to accept and retain, and which to ignore and reject. See for example Godbout (1999). In KM this selection can be defined as a filtering process which the knowledge worker does or which is potentially performed automatically by a software agent. These authors perceive these activities as potentially offering the highest return on investment in KM, but also as being one of the most challenging to realise. There are a number of knowledge-specific issues to resolve before this ideal can be fully automated. As decision makers, the knowledge workers are not only overwhelmed with information, but they are also frequently confronted with conflicting information. They also have to judge the value of the information on which decisions should be based.

We suggest at the end of this study that this particular topic justifies further research because of its value for KM.

6.6 Information and Knowledge Linking

A major difference between a document base and a knowledge base lies in the linking of the information objects (such as documents and abstracts) to related information. This is very effectively achieved via hypertext linking. The approach of utilizing hypertext ensures that the linear appearance of documents is transformed into a multi-dimensional appearance. Hypertext linking also enables the browser software to effectively handle multi-media documents. The problem with this approach, however, is that the hypertext links have to be assigned manually by the authors of the documents.

New research into so-called "**liquid information**" utilizing "**hyperwords**" has a huge potential for a major enhancement to the handling and searching of documents. We suggest at the end of this study that this concept could be the subject of further research for KM. See in this regard the two Web sites dedicated to this research, namely: www.liquidinformation.org and www.hyperwords.net.

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In the next chapter we focus on the applications identified by the KM technology framework.

Chapter 7 KM Technology Framework Applications

> ***Computers can figure out all kinds of problems, except the things in this world that just don't add up. –*** J. Magary

7.1 Introduction

The KMTF listed two key KM applications, namely: "knowledge portals" and "knowledge discovery" which we cover in the following two chapters. In this chapter we introduce a number of other KM applications we deemed important enough to be in scope of this study.

In the next section we make remarks about intelligent agents as KM technologies. In the sections thereafter we mention knowledge mapping, and discuss expertise mapping and locating. In the last section we make brief remarks about analysis and decision making in relation to KM.

7.2 Intelligent Agents and KM

We discussed the phenomenon of the information overload in chapter 6. While the Web allows various kinds of knowledge to be created and disseminated across time and space barriers, it does not support the processes of using and updating the knowledge in a timely manner. In this regard intelligent agents have been suggested (see for example Baek et al (1999)) as a promising solution for assisting and facilitating these processes. Many definitions[57] have been proposed for the concept of an intelligent agent. For example: "***anything that can be viewed as perceiving its environment through sensors and effects***" and the AI approach "***intelligent agents continuously perform three functions: perception of dynamic conditions in the environment; action to affect conditions in the environment; and reasoning to interpret perceptions, solve problems, draw inferences, and determine actions.***"

We prefer the following ***definitions of an software agent and an intelligent software agent*** as described by Firestone (2003), which is a culmination of many previous attempts and fit into our approach for KM.

A **software agent** (SA) is a software object that acts on behalf of another software object (its client) and has the following behaviour:

- Is autonomous
- Interacts with other agents
- Is proactive; meaning it influences its environment

[57] Many definitions have been published before: see for example Firestone (2003)'s list and discussion as well as the table in Baek et al (1999).

- Is reactive; meaning it is influenced by its environment

An **intelligent software agent** is an SA that:

- Has an in-memory knowledge base that includes cognition, evaluations, and goals
- Is rational in the sense that it makes decisions
- Acts to attain its goal
- Learns.

Therefore an intelligent agent that is delegated a task by a user, should determine precisely what its goal is, evaluate how the goal can be reached in an effective way, and perform the required actions that are goal-oriented and flexible. An intelligent SA should also be capable of learning from past experiences and responding to unforeseen situations with its reasoning strategies of being adaptive, self-starting, and time-sensitive (temporal). It should be reactive to its current environment and act independently to reach its goal.

Typical intelligent SAs can be employed as two major applications of intelligent SA technology, namely: ***personal assistants*** and ***communication agents*** (Baek et al (1999)).

Personal assistants focus on the interaction between a user and the computer. They typically perform repetitive and burdensome tasks on behalf of the knowledge worker. For example, automatic disk backup, information filtering, automated information retrieval, mail management, and meeting scheduling. What makes intelligent agents unique is two-fold: first, they use machine learning techniques to adapt to user habits and preferences; and, second, they use automated reasoning so they can decide when to help the user, what to help the user with, and how to help the user.

Communication / Collaboration agents focus more on the interaction among computing agents, specifically geographically distributed agents[58]. An example would be that one agent asks another agent for information instead of attempting to find the information on its own.

With regard to knowledge management, the typical tools utilised on the corporate knowledge bases and the Web have been designed for efficiency and knowledge worker productivity. Tools such as groupware are used for collaboration and knowledge sharing among teams of people inside and outside an organization.

Agents can support knowledge workers to augment searching tools because these tools are unable to provide the user with time-sensitive knowledge. Knowledge workers, who perform knowledge-searching tasks, need to be aware of changes in the organization's knowledge. This

[58] They communicate in a universal language to other agents enabling platform and implementation independence.

offers a huge opportunity for intelligent agents to assist in solving these problems. The intelligent agents perform repetitive and mundane tasks to enhance KM on behalf of the knowledge workers. Baek et al (1999) have published a table of the assistance given by different intelligent agents for KM tasks and processes.

7.3 Knowledge Mapping (briefly)

The mapping of the available knowledge in the organization for knowledge workers to locate and access, forms an important part of the deployment and operation of a KM program. We have discussed this topic in part with our discussion on the types of knowledge bases, specifically the corporate Yellow Pages knowledge base on page 41 in this regard. A number of references to knowledge mapping include: O'Dell and Grayson (1998) who have referred to "pointer systems", Davenport and Prusak (2000), Maybury (2003), Daconta et al (2003) who described topic maps in detail, and Firestone (2003).

We regard details about this topic, however as out of scope for our focus.

7.4 Expertise Mapping and Locating

(See also related description in chapter 4 about "Tacit to Tacit" on page 51.)

Suppose one's goal is not to find someone with common interests but to get advice from an expert who is willing to share his or her knowledge. Expertise location systems have the goal of suggesting the names of persons who have knowledge in a particular area. In their simplest form, such systems are search engines for individuals, but they are only as good as the evidence that they use to infer expertise. Some possible sources of such evidence are as follows (Marwick (2001)):

Sources of evidence for an expertise location system

- A profile or form filled in by a user
- An existing company database, for example one held by the Human Resources department
- Name-document associations
- Questions answered

The problem with using an explicit profile is that persons may not be motivated to keep it up to date, since to them it is just another form to fill in. Thus it is preferable to gather information automatically, if possible, from existing sources. For example, a person's resume or a list of the project teams that he or she has worked on may exist in a company database. Another automatic approach is to infer expertise from the contents of documents with which a person's name is associated. For example, authorship (creation or editing) of a document presumably indicates some familiarity with the subjects it discusses, whereas an activity such as reading indicates some interest in the subject matter.

Two approaches to using document evidence for expertise location suggest themselves: either the documents can be classified according to some schema, thus classifying their authors; or when a user submits a query to the expertise location system, it searches the documents, transforms the query to a list of authors (suitably weighted), and returns the list as the result of the expertise search.

The current state of the art is to use the first three sources of evidence listed above, namely: explicit profiles, evidence mined from existing databases, and evidence inferred from association of persons and documents. For example, the Lotus Discovery Server product (Pohs et al (2001)) contains a facility whereby an individual's expertise is determined using these techniques, while it analyzes the e-mail a person writes, to form a profile of his or her expertise. Given the properties of on-line discussions, discussed in chapter 3, it is reasonable to suppose that a fourth source of evidence could be the content of the questions answered by a person in such a system, with the added advantage that such a person is already willing to be helpful.

A typical "***expert locator***" should have the following characteristics:

- It allows users to search through a set of biographies for an expert on a specific knowledge domain.
- Its objective it locating people not documents.
- It contains information about human experts such as: educational background, jobs held, current projects and responsibilities, skills, languages spoken, or proficiency.
- An expert locator includes a keyword-based guide to the domains of expertise in the company. For example: searching for an expert on the topic of "IT Governance", it should be easy to connect with experts having that expertise by searching on that keyword-based phrase or by doing a taxonomy-based search

Technology needed for expert locators is relatively straightforward: it requires a Web browser and server software, DBMS and search engine. The search engine should be supported by a thesaurus or ontology because expertise search may not match directly. The main difficulties encountered for companies to implement expert locators are non-technical. The systems require a considerable time commitment on the part of the expert (or some intermediary) to enter and update biographies into the database. Motivating experts to comply with this may be difficult[59].

[59] There also may be political issues to name some people "experts".

7.5 Analysis and Decision Making (briefly)

As stated before, we regard applications such as business intelligence (BI) and data warehousing as pure IT applications. These technologies play an important supportive role for KM and certain techniques are shared between BI and KM. Cody et al (2002) argues that BI and KM may eventually be merged into a new discipline that handles data, unstructured information, and knowledge. Says Codey et al (2002):

> "***We call this blended technology BIKM. . . .***
>
> ***The desire to extend the capabilities of business intelligence applications to include textual information has existed for quite some time. The major inhibitors have included the separation of the data on different data management systems, typically across different organizations, and the immaturity of automated text analysis techniques for deriving business value from large amounts of text. The current focus on information integration in many enterprises is rapidly diminishing the first inhibitor, and advances in machine learning, information retrieval, and statistical natural language processing are eroding the second.***"

In their article Codey et al (2002) describe their contribution in this regard. For example, their "eClassifier" is a comprehensive text analysis tool that provides a framework for integrating advanced text analytics. (See more related discussion in chapter 9.)

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In the next two chapters we cover the two key KM applications of "knowledge portals" and "knowledge discovery".

Chapter 8 Knowledge Portals

I may not know the answer to your question. But, I can find someone in five minutes who does! – Henry Ford

8.1 Introducing the KMTF User Interface and Integration Platform

In this chapter we consider the key KM application of Knowledge Portals. This application combines many of the issues pointed out in this study into a solution for KM. We recognize the current publicity and popularity surrounding "portal" technology. From the functional standpoint, portals are defined as an access point to the "corporate" memory (the integrated interface) and represent the possibility of an integrated KM "total" solution. A knowledge portal therefore fulfils a key role in KM. It is this interpretation of portals that is presented throughout this chapter.

Recently the concept of portals – information portals, knowledge portals, as well as enterprise information portals – has become very popular. The many interpretations that result from a plethora of vendor offerings could cause confusion about this concept. It has therefore become desirable to clearly define and describe the concept and to position it for our purpose. This is the topic of the next section.

8.2 Knowledge Portal Concepts

A major function of knowledge management is to provide users with an interface that is comfortable and intuitive, yet powerful. Given the current pervasiveness of the Internet, it is not surprising that many recent KM developments have chosen the web browser to be the user interface, with access to information via a centralized access point, often known as an Enterprise Information Portal (EIP). There are a variety of EIP implementations available, but most include the following common elements:

- Personalization, allowing users to customize their EIP workspace by means of tools such as software agents and filters.
- A unified search and retrieval system for text (and possibly multimedia objects), using intuitive techniques such as more natural language interfaces.
- Collaboration, providing messaging between users, and collecting data on the relevance and usefulness of information presented, which can then be fed back to improve the EIP.
- Access to applications, in most cases eliminating the need for installing and maintaining them on individual workstations.

An information portal that is specifically utilized by knowledge workers is called a **knowledge portal** (K-portal; Mack et al (2001)). Knowledge portals are rapidly evolving into broad-based platforms for supporting a wide range of knowledge worker tasks. Mack et al (2001) refer to these broad-based platforms as the ***knowledge workplace***. K-portals serve tasks performed by knowledge workers. Knowledge workers typically gather information relevant to a task, search it, organize it, analyze it, synthesize solutions with respect to specific task goals, and then share and distribute what has been learned with other knowledge workers[60]. K-portals are specifically designed to assist with these tasks.

A portal is much more than a launch pad. It supports integrated access to information, applications and people, in context. One can identify at least the following **functions** of a full-function K-portal:

- Personalization – customizing the user's interface based on their preferences.
- Access and advanced search – delivering information in context regardless of type/media, location, platform; including multi-repository support.
- Categorization – cataloguing information assets and understanding relationships via meta-data; employing a meta-data dictionary and taxonomy.
- Collaboration – the ability to connect users of a similar interest and assist them to work together.
- Application integration – integrating information with processes.
- Security and directory management – protecting assets and simplifying the user's experience with all the underlying technology.
- Development tools – visual components, navigation and mapping.

The K-portal therefore, provides a secure, single point of access to diverse information, business processes, and expertise regardless of location or structure. This is done in context to a user's needs and responsibilities while leveraging all forms of information, applications and expertise.

K-portal technology provides convenient meta-data about documents in its domain. We have already discussed two examples of such meta-data: search indexes and a knowledge map or taxonomy. One of the keys to a successful K-portal is the establishment of a **taxonomy** that applies a structure, typically hierarchical, to the available information. Simple taxonomies can be seen on public portals such as Yahoo!, but a K-portal is usually considerably more complex, since it must handle information in diverse formats from a number of different sources. It is envisaged that increasing use of natural language processing in portals will generate new kinds of meta-data (Marwick, 2001). The meta-data can be automatically generated as part of the indexing service of the portal. The generation can take place when the documents are indexed. The value of the meta-data lies in encapsulating information about the document. This can then be used to build selective views of the document space; for example listing documents in a required category.

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[60] Sourced from Mack et al (2001)

In Figure 26 we illustrate the conceptual view of a typical K-portal. The K-portal offers a single point of access to a wide diversity of user devices – such as PCs and intelligent handheld devices. The users experience a secure and personalized user interface based on interface rules, profiles and roles. The presentation typically combines the content of a variety of information sources from rich content management environments in a standardized format. Personalized access is given to different applications in an integrated manner; and sophisticated collaboration is enabled with other knowledge workers.

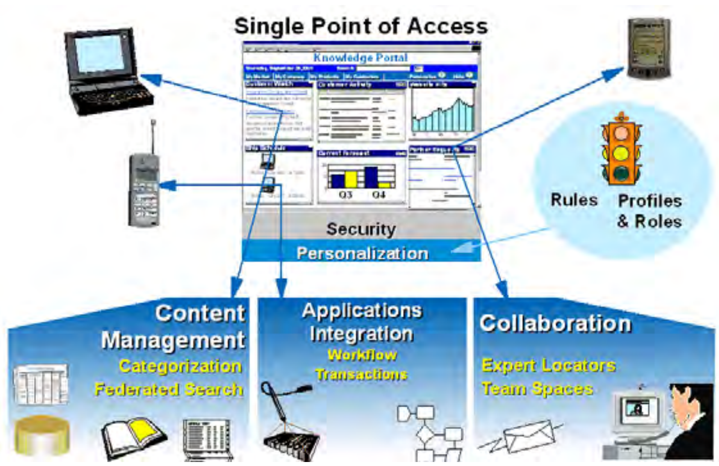

Figure 26: Conceptual Knowledge Portal

In Table 5 we compare the functionality of knowledge retrieval as described in chapter 6 with the enhanced characteristics of a K-portal. This clearly illustrates the richness of K-portals and why we argue that they play such a key role for KM.

Knowledge Retrieval	**Knowledge Portal**
Search	Browsing, organizing, suggesting, updating
User preferences	Personalization
Interface organizes to fit content	Content may be organized to fit interface
Internal content	Internal and external content
Unstructured data	Unstructured and structured data
Document-centric and impersonal	Human element, sense of community
Explicit profiling	Explicit and implicit profiling

Table 5: Comparison of Knowledge Retrieval and a Knowledge Portal

8.3 K-portal Architecture

A reliable, secure, scalable, and manageable K-portal product needs a number of architectural components. The components of a particular portal may be highly visible functions such as personalization or may be totally hidden from users such as the meta-data dictionaries. Architecturally, as suggested in Figure 26 above, K-portals have several required services:

- A personalization engine – which personalize the look-and-feel as well as the available functionality for the particular knowledge worker.
- A search engine, including crawlers for indexing data repositories.
- Collaboration functionality – which let the knowledge worker collaborate with other knowledge workers; asynchronously such as utilizing e-mail or synchronously such as utilizing instant messaging.
- Application integration middleware or similar connectivity technology and networking – which integrate different "back-end" applications and combine results and presentation in a standardized format.
- A powerful relational database.

Presently, an application server may still be optional, but it is a requirement for future-generation K-portal technologies. A taxonomy engine is also optional today, but manually tagging documents to populate the taxonomy is a very people-intensive and error-prone exercise. Automatic taxonomy creation, document and concept classification, as well as semantic analytic taxonomy engines are still far from perfect. However, we expect automatic taxonomy engines to continue to be demanded by knowledge portal users and therefore to be included in future enterprise K-portal functionality when they have matured enough.

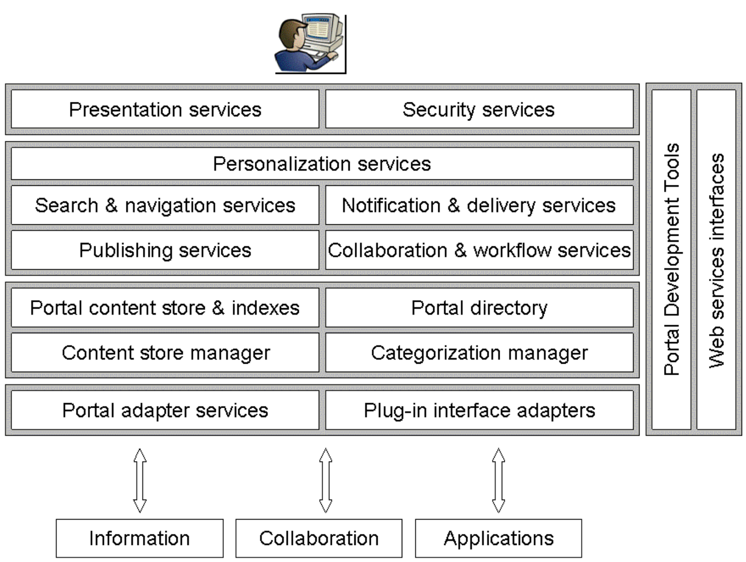

Figure 27: Typical K-portal system configuration

In Figure 27 we illustrate and summarize a typical system configuration of a K-portal (derived from many sources such as Han (2003)).

A number of companies are experimenting with technologies for K-portals and some K-portals are currently actively utilized by knowledge workers. The sophistication of these K-portals are constantly being enhanced. See a list of candidates of commercial offerings in the survey of Firestone (2003).

8.3 Summary

K-portals provide most of the robust technology functions required for KM. It serves as the common knowledge workplace for the knowledge workers thus as the KM user interface and integration platform of our KM technology framework. With the K-portal we therefore combine access to the many enablers of KM that we listed in Figure 7 on page 19.

A K-portal addresses many of the KM functionality we referred to so far.

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In the next chapter we cover the key KM application of “knowledge discovery”.

Chapter 9 Knowledge Discovery

Ours is the age which is proud of machines that think, and suspicious of men who try to.
– H. Jones

9.1 Introduction

In this chapter we consider knowledge discovery as the other important application relevant to KM alongside knowledge portals. In this regard we discuss various aspects in concept, and indicate a number of topics for further research. We briefly refer to a number of technologies and techniques for performing knowledge discovery, focusing mainly on text mining. This area is a discipline in its own right and is being actively researched.

Knowledge discovery is a process that attempts to identify and interpret patterns in information that are potentially important in performing some task. The patterns are defined relative to the task. Depending on the task, knowledge discovery can be partially or fully automated. Because of having to contend increasingly with the information overload as a reality, the need for more automated knowledge discovery has recently become more acute. It is becoming more feasible to contend with the huge volumes of information because of the ongoing increase in computing power at relative affordable costs, and because of the availability of more scalable algorithms to handle huge data sets. Although the term ***discovery*** means the act of finding something that already exists, that does not imply that it is necessarily a quick or easy process.

Organizing information such as business rules and statistical summaries is an important interim step in the process of collecting and analyzing it, so that the analyzed information can be used as knowledge (tacit or explicit). What is as important as simply organizing information, in generating or discovering explicit knowledge is the determination of the information's context. We require knowledge structures in the form of an ontology, as previously described, as an important part of knowledge discovery. Ontologies define the relationships among various bits of information in a collection. These relationships add context to the information for a particular task.

Becker (1999) utilised the diagram in Figure 28 to illustrate the dilemma of the knowledge worker in discovering knowledge. On the left-hand side is the ever-increasing information growth (say as on the Web) and on the right-hand side the desired relevant information. The available search engines on the Web can serve as the automated filters that return a few thousand hits to a query among the millions of available documents. The knowledge worker task, however, is still a manual task of sifting out those relevant answers that can be confidently used for the decision making process.

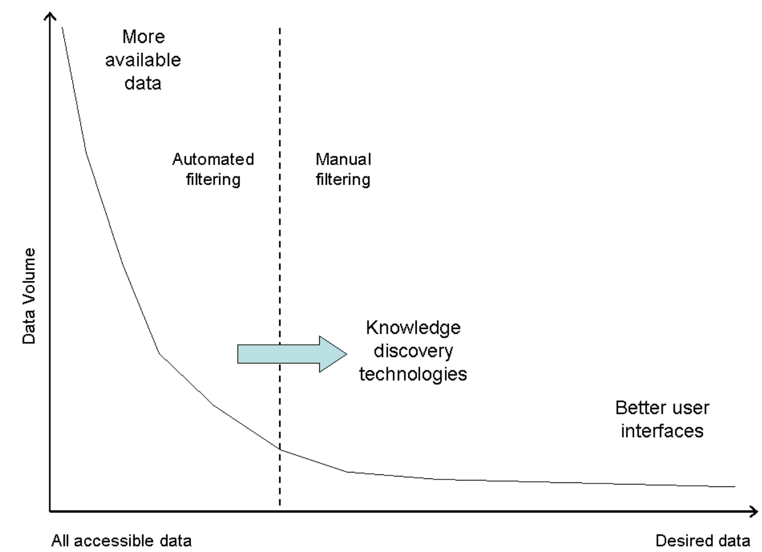

Figure 28: Information Filtering and Knowledge Discovery

The goal of knowledge discovery technologies is to use knowledge about the user and the user's goals to move the automated filtering line in the diagram toward the right. At the same time, better data visualization techniques are being developed that allow the user to see and work with hundreds or thousands of documents simultaneously; for example: displaying documents found as a scatter diagram or citation diagram.

9.2 Positioning Knowledge Discovery Techniques and Technologies

Individuals do not always know what they do not know and follow different strategies to obtain knowledge that was hitherto unknown to them. Sometimes, just talking to an expert is the best way to learn – thus to discover knowledge. But, knowledge discovery is also achieved when the knowledge worker is supported by knowledge discovery technologies. Knowledge discovery is a way to find access to all the relevant information in a corporate environment without prior knowledge of its existence.

We can classify the different knowledge discovery techniques and technologies into three major areas in terms of the explicit knowledge media, namely as:

Data mining in structured data. In this area, structured information databases are analysed in the hope of discovering hidden patterns in data records that may not have been obvious in the general usage of these databases. This area of knowledge discovery is usually applied to information in data warehouses. We restrict ourselves to making some brief remarks about it in relation to KM. This area is discussed in the section on data mining.

Text mining. This area is important for KM because of the large percentage of explicit textual knowledge in the typical organization. We cover techniques related to this area in the section on document and text mining.

Data mining in multi-media. Although most knowledge discovery is being done on structured data and text, some organizations possess large multi-media assets such as image, audio, and video. It is an open question whether these assets can be made more valuable by utilizing knowledge discovery techniques. This is a fairly new research area and we make the suggestion at the end for this too to be an area of further research for KM.

A typical knowledge discovery server should perform the following main functions[61]:

- It should automatically find, organize, and map disparate content on behalf of the knowledge worker.
- It should build a network to locate subject matter experts.
- It should add value to content by maintaining its context and by incorporating the opinions and judgements of individuals.

9.3 Data Mining

As stated in the introduction we make brief remarks on this topic as we regard it as part of the business intelligence and data warehouse application set as mentioned in chapter 7.

Over a number of years advanced data mining algorithms, tools, and systems have been developed and are actively in production in many industries. Suffice for us to display a categorization of the different data mining algorithms that are typically utilized. This is illustrated in Figure 29. Pattern recognition algorithms are used to find patterns in information databases. Some of these algorithms use statistical methods and others use symbolic methods. Selecting the best algorithm for any application of data mining depends on the information format and application goals.

Statistical methods measure important characteristics (or features) of the information. These characteristics are plotted into an n-dimensional feature space (n being the number of features). These plotted values are then divided into classes and clusters. Algorithms that are classified into the statistical group include neural networks and decision trees.

Symbolic methods are utilized to find structure in the information. They look for pattern primitives using pattern description languages. Pattern primitives can be parts of speech in text, pixel

[61] See Pohs et al (2001) and their description of the Lotus Knowledge Discovery System: the K-station portal and the Discovery Server.

patterns in an image, or a particular pattern of values in a time series. A symbolic method uses a ***grammar*** to govern how patterns can be put together to form (symbolic) **sentences** which are higher order structures of pattern primitives (Becker (1999)). Recognition is done by parsing sentences, in a quest for groups of patterns that fit into the application's ***grammar***.

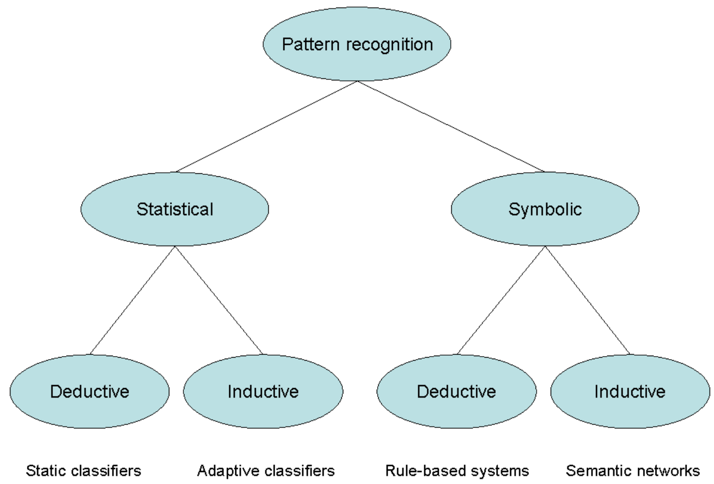

Figure 29: Pattern recognition algorithms

Both statistical and symbolic methods may be deductive or inductive. Deduction is a process that starts with a general ontology and matches it to specific examples. Deductive methods include rule-based and case-based reasoning systems. Induction, also called concept learning, is a process that uses examples to build a general ontology that describes the information patterns. Decision trees, neural networks, and other machine learning techniques are all inductive (Becker (1999)).

We close this section by drawing attention to the four basic classifier approaches that are associated with the leaves of the classification tree in Figure 29.

- Static classifiers
- Adaptive classifiers
- Rule-based systems
- Semantic Networks

9.4 Text (and Document) Mining

A great wealth of knowledge is potentially included in large text document bases. However, from the point of view of routine computational mechanisms, natural language text represents much of this knowledge in a complex, rich and hidden way. Therefore, the typical statistical techniques used in data mining cannot be use directly for text.

On the other hand, human analysis of these volumes is becoming increasingly impractical. Therefore, there is considerable interest in text mining techniques and technologies. As discussed in chapter 6, information retrieval technologies allow the user to select documents that meet the user needs. In contrast, the text mining technologies focus on finding valuable patterns and rules in text that indicate trends and significant features about topics in the documents.

Nasukawa and Nagano (2001) have published a comparison of document-handling technologies that have been developed to reduce the work in handling huge amounts of textual data. We adapted and included this comparison in Table 6.

Function	**Search documents**	**Organize documents**	**Discover knowledge**
Purpose	Focus on data related to some specific topics	Overview of topics	Extract interesting information from content
Technology	Information retrieval	Clustering, classification	NLP, data mining, visualization
Data representation	Character strings, keywords	Set of keywords (vector space model)	Semantic concepts
Natural language processing (NLP)	Keyword extraction (conversion to basic forms)	Analysis of keyword distribution	Semantic analysis, intention analysis
Output	A set of documents	Sets (clusters) of documents	Digested information (trend patterns, association rules, etc.)

Table 6: Comparison of document-handling technologies

In the table, different functions in the rows are compared in relation to the columns about "searching documents", "organize documents", and "discovery of knowledge". In particular we emphasise the different technologies, data / knowledge representation, as well as natural language processing (NLP). It is clear from this comparison that many of the techniques and technologies of knowledge discovery are based on the analysis of natural language text features and recognition of the semantics. In essence then, these technologies are a text version of generalized data mining. It consists of NLP to extract textual concepts, statistical analysis (data mining) to find interesting patterns among these concepts, and visualization to allow interactive analysis.

Text mining can therefore be seen as the set of techniques and technologies utilised to achieve the following:

- Find key items of information in a large collection of text, for example, by scanning a large collection of text and then indexing it by “company name”.
- Rediscover authors 'intentions, for example, by extracting relations between concepts.
- Synthesize new insights from information implicit in a large collection, for example, by following the transfer of ideas from basic research to industrial application.

Thus, by **definition**, text mining is the process of analyzing texts to extract information useful for a particular application.

Text, in contrast with data, has a varying degree of ***structure***. This can range from low to high structure. For example:

- Prose does not have an explicit structure. Any structure is implicit. Text mining extract useful information from these non-structural features.
- Documents may have some structure such as the title, abstract, and author. Even utilizing XML may result in text having deep or shallow structure. Text mining makes limited use of document structure.
- Meta-data is highly structured and one of the applications of text mining is to generate new meta-data.

The goal of text mining is to discover (or uncover) (hidden) ***features*** in the text. Features include words, phrases, names, nouns, abbreviations, acronyms, etc. A typical large text collection may contain about 100,000 features. The techniques employed for the analysis include counting, comparing of lists, discovering similarities, etc.

But, this is not a simple task, as natural language poses a number of challenging issues for automated processing. The vocabulary problem is one such challenge. For example, the issue of ambiguity: “savings bank” and “river bank” are similar in construct but have vastly different semantics; also synonymy: “car” and “automobile” are equal concepts. Text mining also considers other features such as hyperlinks and citations which can convey rich relationships between documents and can be indications of the value of text documents. The analysis may also take characteristics such as sentence length and grade level of the text into consideration.

Comments on Summarization and Automatic Extraction

Document summaries constitute a kind of meta-data that reflects a short view of the whole document and that enables users to quickly sift out documents relevant to a particular task. Automatic generation of summaries is being actively researched. Marwick (2001) comments as follows:

> "***Commercially available summarizers use the sentence-selection method … in which an indicative summary is constructed from what are judged to be the most salient sentences in a document. However, the summary may be incoherent, e.g., if the selected sentences contain anaphors. Construction of more coherent summaries, implying the use of natural language generation, currently requires that the subject domain of the documents be severely restricted, as for example, to basketball games. Summarization of long documents containing several topics is improved by topic segmentation and can be further condensed for presentation on handheld devices, whereas summarization of multiple documents, either about the same event or in an unconstrained set of domains, is another challenge being addressed by current research.***"

Marwick (2001) also comments on automatic extraction, as follows:

> ***"Today the level of automatic extraction is deemed to be rather shallow because only a subset of the meaning, sometimes a very limited one, can be captured, ranging from recognition of entities such as proper names or noun phrases to automatic extraction of ontological relations of various kinds, and there is no system that can reason (in the sense of deducing something new from what it already knows) over the extracted knowledge in a way that even approaches the capabilities of a human".***

See also Radev and McKeown (1998), Mani and Maybury (1999), and Boguraev et al (2001).

Applications of text mining technology

Text mining can be utilized in a host of different applications such as the following list.

- Annotate: Annotate a document with meta-data that is generated from the document.
- Search: Search for and pull related documents from the repository.
- Navigate: Navigate through a repository of text using organization and document links to find information.
- Organize: Organize parts of text by placing it in context of a structure.

Nowadays, the emphasis is put on problems connected to the World Wide Web and applications involving intelligent agents for text data. Knowledge discovery techniques also include different approaches to text data analysis aiming at problems such as: assignment of keywords to text documents, topic identification and tracking in ordered (time) sequences of text documents, searching documents based on the content categories and not only keywords, generation and analysis of user profiles based on the usage of text databases, as well as other related problems.

The following is a list of applications of text mining technologies that is been actively researched[62]. Text Mining can be used for...

- Automatic document categorization / Topic detection
  - Measuring similarity between the documents
  - Document clustering
  - Categorizing to flat categories
  - Categorizing to hierarchical categories (e.g. Yahoo!)
  - Inventing new categories from the text
  - Custom (e.g. emotional) profile detection of documents
- Operations on single documents
  - Document summarization
  - Keyword assignment to documents
  - Text segmentation
- Operations on multiple documents
  - Hierarchical subject index creation from the document set
  - User profiling based on the text (a connection to Web mining)
  - Information extraction from unstructured documents
  - Topic tracking for news wires
- Advanced topics
  - Text visualization
  - Analyzing networks of linked documents
  - Inferring communities on the Web
  - Copy detection
  - Authorship detection
  - Text mining tools

[62] Compiled from a number of conference proceedings on text mining

Text mining technologies summary

We display the key text mining technologies applicable to KM in Figure 30 as a set of nine technologies that can be utilized to assemble or build the text mining applications and solution (displayed in the diagram on top of these technologies).

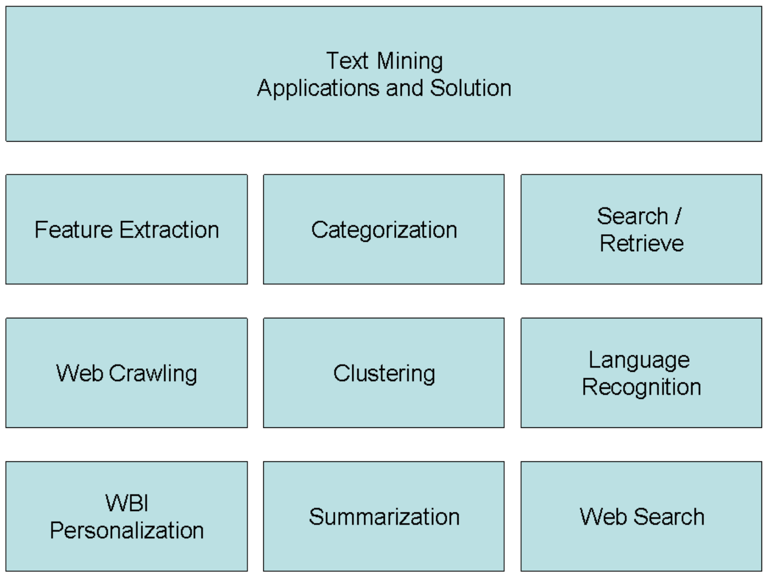

Figure 30: Key Text Mining Technologies

To demonstrate the practical nature and extent of knowledge discovery in practice, in the next subsection we show the product features of a commercially available text mining product providing extracted text from the product's description documentation.

Example: The Text Analysis Tools of IBM Intelligent Miner for Text

“Text mining technology deals with all kinds of online documents: customer requests, technical reports, online newspaper articles, and many other kinds of text documents. The technology provides functions that information consumers normally do manually given sufficient time.

“These functions include:

- Annotate documents

  How often does one print out online information and then highlight important items, such as the names of significant companies? This can be done automatically using feature extraction.
- Organize documents

  Today it is commonplace to have a folder scheme on a desktop. A folder scheme is a simple cataloguing mechanism for sorting items by subject. The assignment of new items to a scheme can be done automatically using topic categorization.
- Navigate through documents

  When following a thread of information, one may be led from one document to another looking for similar documents or predominant themes in a collection. Here hierarchical clustering can automatically give an overview.

“The text mining technology is designed to be used in building applications that deal with text. Often the first step is to extract key features from text that can be used as "handles" in further processing. Examples of features are company names, dates, or technical terms mentioned.

“After feature extraction, the next step may be to assign the documents to subjects from a cataloguing scheme, then to index them for searching. Or the documents can, with very little preliminary work, be grouped, or clustered to get more information about the structure of a document set, such as the distribution of subjects across a document collection, or accumulations of documents on a certain subject.”

Tools summary

“The Text Analysis Tools consist of:

- The Feature Extraction tool. This tool recognizes significant vocabulary items in text, automatically, and without requiring the user to predefine a domain-dependent vocabulary.
- The Language Identification tool. This automatically discovers the language in which a document is written. A training tool lets users extend the tool to cover additional languages.
- The Topic Categorization tool. This tool automatically assigns documents to categories, topics, or themes that have previously been defined.

- The Clustering tools. These tools divide up a set of documents into groups, or "clusters", with the members of each cluster being similar to each other by sharing common features. The clusters are not predefined; they are derived from the document collection automatically."

Feature Extraction

"An important task in text analysis is the extraction of items that provide information about document content from unstructured text. Extracting implicit data from text can be interesting for many reasons. Here are some examples:

- To highlight important information
- To find names of competitors
- To find and store key concepts
- To use related topics for query refinement
- To find the criteria that relate a collection of documents

"One can combine feature extraction with other text mining technologies. It can be used, for example, as a pre-processing step for the clustering technology to cluster documents with respect to different aspects like the names of people or organizations mentioned in a text, or key topics of the documents."

Name extraction

"The name extraction technology uses fast and robust heuristics to locate names in text. It determines what type of entity the name refers to, for example, person, place, organization or historical event. Even though the name extraction technology does not rely on a complete pre-existing database of names, IBM measured it to correctly recognize 90-95% of the proper names present in edited text."

Terminology extraction

"The term extraction technology discovers terms in text automatically. A set of heuristics is used to identify multi word technical terms in a document. These heuristics involve doing simple pattern matching in order to find expressions having the characteristic noun-phrase structure of technical terms."

Abbreviation extraction

"The abbreviation recognition technology finds additional variants for terms and names in text and matches them with their full forms. "EEPROM" and "electrical erasable PROM" are, for example, recognized as a short form for "electrical erasable programmable read-only memory". A variety of common abbreviation conventions can be handled, such as conventions involving pre-fixation as in "MB" matching "megabyte"."

Language identification

"The language identification technology can select from a given set of languages the most likely language in which a textual document is written. This works by computing a similarity measure between the document at hand and a set of reference document collections, one for each language to be recognized. These collections, or more precisely, the statistical features extracted from them, are stored in a language identification scheme, sometimes also called a master dictionary, which is used for comparison. The language identification scheme shipped with this product supports 13 languages."

Topic categorization

"For text mining, categorization means to assign categories to documents, or to organize documents with respect to a predefined organization. These could for example be the folders on a desktop, which are usually organized by topics or themes.

"The categories are chosen to match the intended use of the collection and have to be trained beforehand. By assigning documents to categories, the text mining technology can help to organize them.

"While categorization cannot replace the kind of cataloguing a librarian does, it provides a much less expensive alternative. In addition, it can be very useful in many other applications:

- Organizing intranet documents. For example: Documents on an intranet might be divided into categories like "Personal policy" or "Computer information". By using automatic categorization, any document can be assigned to an organization scheme and a link to the respective category can be generated automatically.
- Assigning documents to folders. For example: Categorizing incoming e-mail items into folders.
- Sending requests. For example, by categorizing problem reports, the message can be automatically forwarded to the respective expert.
- Forwarding news to subscribers depending on their area of interest.

Categorization can of course be combined with other text mining technologies as well."

The training phase

"Topic categorization assigns documents to predefined categories. For this purpose. the topic categorization technology first **has to be trained** with a collection of sample documents for each category. These collections are used to create a category scheme.

The training uses the feature extraction technology to store only relevant information in the dictionary. The category scheme is a dictionary which encodes in a condensed form significant vocabulary statistics for each category. These statistics are used by topic categorization to determine the category or categories whose sample documents are closest to the documents at hand."

Clustering

"Within a collection of objects, a cluster can be defined as a group of objects whose members are more similar to each other than to the members of any other group.

"In text mining, clustering is used to segment a document collection into subsets (the clusters), with the members of each cluster being similar with respect to certain interesting features. No predefined taxonomy or classification schemes are necessary."

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In the last chapter we conclude this study with a brief summary, conclusions, and some remarks and indications for further research on this topic.

Chapter 10 Summary and Conclusions

> ***There is no conclusion to managing knowledge and transferring best practices. It is a race without a finishing line***. – O'Dell and Grayson (1998), Part Six: Conclusion
> ***The great end of knowledge is not knowledge but action***. – Thomas Henry Huxley

10.1 Introduction and Conclusions

Not all KM projects are successful. (This is obviously very true for all "general class" projects too.) We need to investigate the reasons why such projects have failed and also why other – even similar projects – were successful. The article of Malhotra (2004) was such an investigation. Its key thesis was "***that most failures could be contributed to enablers of KM that was designed for the 'knowledge factory' engineering paradigm and often become constraints in adapting and evolving such systems for business environments characterized by high uncertainty and radical discontinuous change. Design of KMS[63] should ensure that adaptation and innovation of business performance outcomes occurs in alignment with changing dynamics of the business environment.***"

Malhotra's article emphasises the rapid change of the business environment and the typical response made by organizations by utilizing KM and KM technologies. Our main thesis throughout was that KM relies on KM technology as a necessary but not sufficient prerequisite; as an enabler of KM. We have stated that knowledge management is concerned with realizing the value of an organization's intellectual assets and with determining how to manage these assets so as to more effectively make strategic and tactical decisions and solve problems. It is technology's role to support this process.

Both in Part 1 and Part 2 we have adapted and employed different models to assist in the comprehension of the notion of KM and its different perspectives. In Part 1 we have covered the "What-is" and "Why-is" aspects of knowledge and knowledge management.

In Part 2, we have covered the "How" and "With-what" characteristics of KM. We have concentrated on the KM technologies perspective and have proposed a Knowledge Management Technology Framework. This framework enabled us to categorise KM technologies and KM applications into six major categories. We exploited this framework to comment on and describe the six categories and their implications as they affect KM.

We stressed the value of the two key applications of KM namely "knowledge portals" and "knowledge discovery". The importance of XML technologies and other semantic rich efforts to move toward the Semantic Web was emphasised and we pointed to the richness of functionality and huge potential of many developments in KM technologies.

[63] KMS – knowledge management systems

Conclusions

We can conclude that this study strengthened and emphasized our main thesis that KM technologies will increasingly be felt as necessary but not sufficient prerequisites for the success of KM; specifically in medium-to-large-scale organizations.

In Part 1 we reached the conclusion that KM itself will eventually become "just business" and therefore "invisible" in organizations. Organizations will incorporate the concepts and principles of KM into the day-to-day running of business. In Part 2 we described various KM technologies that we may also regard as becoming "invisible" as they are converged and incorporated into fast evolving areas as "business enabling" technologies and no longer regarded as pure KM technologies. This may take quite a while though; because so-called "common knowledge" and the human faculties that we take for granted are so complex and rich that they cannot easily be translated into software, as researchers are constantly rediscovering. KM and the effort to develop and evolve KM technologies humble us as we come to realize just how elusive a full comprehension of the concepts of knowledge and its related ideas are.

On a more technological note, we also are in agreement with the industry consultants, Gartner Group, as they have observed a new type of "suite product" (Gilbert et al (2002)). This suite covers the enterprise needs for content management, knowledge management and collaboration, and supports the extended virtual workplace — inside and between enterprises. They refer to previous examples of aggregation of functionality into suites which have created dominant product categories. Examples include "office suites", which integrate what were originally independent personal-productivity tools; and "enterprise resource planning suites", which grew from manufacturing planning and finance systems, and now cover a wide range of business application functionality. In the workplace area groupware products combine messaging, scheduling and some basic document-sharing functions. It is likely that these "***smart enterprise suites***" will emerge as an aggregation of the functionality offered today by portals, team collaboration support and content management.

10.2 Suggestions for Future Research

As we studied the many aspects and concepts of KM technologies we came across a number of issues that we could only alluded to in the text to date. The study area of KM technologies is rapidly progressing and much research is being done in this area (as we have covered in Part 2).

We have selected a number of topics and areas for further research that we consider will offer key benefits – both theoretical and practical – in the area of KM technologies. We list them here in no particular order.

We contributed to the subject of KM in a number of ways, particularly in proposing our KM technology framework. This framework needs to be employed and tested in real world cases and projects. We foresee that this framework will have to be adapted as new classes of technologies emerge in the future.

Ryan (2005): "***An Alternative for Search and Knowledge Management***", Intranet Journal 2005-09-26 suggested a very interesting concept that he contends can serve as an alternative for search in KM. He termed it "***Intranet Views***". His approach considers search in the same way as the "views" offered by typical intranets.

Broder and Ciccolo (2004) also do research in information retrieval and describe a new interesting concept termed ***Unstructured Information Management Architecture (UIMA)***. UIMA is specifically aimed at unstructured information which plays a key role in KM.

Information and Knowledge Filtering. Because of the information overload, a number of authors allude to the importance of being able to determine which items to accept and retain, and which to ignore and reject; see for example Godbout (1999). In KM this selection can be defined as a filtering process which the knowledge worker does or which is potentially performed automatically by a software agent. These authors perceive these activities to not only potentially offer the highest return on investment in KM, but to also be one of the most challenging. We suggest that further research on this particular topic is justified because of its value for KM.

New research into so-called liquid information utilizing "***hyperwords***" appears to have potential for a major enhancement to the handling and searching of documents. We suggest that this concept be the subject of further research for KM. See in this regard the two Web sites dedicated to this research, namely: www.liquidinformation.org and www.hyperwords.net.

Data mining in multi-media. Although most knowledge discovery is being done with structured data and text, some organizations possess large multi-media assets such as image, audio, and video. These assets can be made more valuable by utilizing knowledge discovery techniques on them. We regard this as fairly new research and make the suggestion for this to be an area of further research for KM.

End of Part 2

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Glossary of Knowledge Management Terms

This glossary[1] provides a preliminary guide to the rich terminology and many interrelated notions of knowledge management. Many of these terms are used by different users and by many commentators without the awareness that they are part of the knowledge management lexicon. Examples of these are: best practice, communities of practice, and core capabilities.

ABC

AI – see artificial intelligence

Artificial intelligence (AI)

> The branch of computer science concerned with making computers behave like humans.
>
> A broad term encompassing anything relating to making computers behave like humans.

Active innovation

> A deliberate searching for new markets and techniques, even though there may be no direct market pressure to do so

Adaptive Agents

> Adaptive agents are agents that can change their internal rules in order to adapt to the environment.

Agent

> An agent is a software program that transparently executes procedures to support gathering, delivering, categorising, profiling information, or notifying the knowledge seeker about the existence of changes in an area of interest.

Audience segmentation

> A communication strategy that consists of identifying certain sub-audiences within a total audience, and then conveying a special message to each of these sub-audiences

Awareness knowledge

> Awareness knowledge is information that an innovation exists.

Balanced Score-Card

> Balanced scorecard system is a method of measuring performance of a firm beyond the typical financial measures. It links corporate goals and direct performance measures in a framework specific to a firm, and is one method of measuring the impact of knowledge management.

Best practice

> A practice can be defined as "know how." Best practices are those practices that have produces outstanding results in another situation and that could be adapted for our situation.

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[1] Sourced from a number of sources found on the Internet such as http://www.knowledgepoint.com.au/ and checked against many book glossaries

BPM – Business process modelling

Building Blocks

Reusable components of a complex whole, such as patterns of facial features, or patterns of rules

Business Intelligence (BI)

Business intelligence is a broad category of applications and technologies for gathering, storing, analyzing, and providing access to data to help enterprise users make better business decisions. BI applications include the activities of decision support systems, query and reporting, online analytical processing (OLAP), statistical analysis, forecasting, and data mining.

Business process modelling (BPM)

BPM is a process that links business strategy to information technology (IT) systems development to ensure business value. It combines process/workflow, functional, organizational and data/resource views with underlying metrics such as costs, cycle times and responsibilities to provide a foundation for analyzing value chains, activity-based costs, bottlenecks, critical paths and inefficiencies.

Call Centre

A physical location where calls are placed, or received, in high volume for the purpose of sales, marketing, customer service, telemarketing, technical support or other specialized business activity.

Call Management System (CMS)

Software used to track customer and employee calls coming into the call centre or help desk.

Case-based reasoning

Case-based reasoning is a branch of artificial intelligence that attempts to combine the power of narrative with the codification of knowledge on computers.

Channel

The means by which a message gets from the source to the receiver

Chaos

A state of a system where patterns exist, but are difficult to discover, in contrast to random where there are no patterns

Chat

Real-time communication between two users via computer

Chief Knowledge Officer (CKO)

An official with the responsibility of leading and managing the knowledge processes of an organization

Class

A collection of things that has a defined quality in common

Codified knowledge

Potentially shared knowledge

Collaboration and Collaborative tools

Collaborative tools include tools such as groupware that facilitate both structured and free-flow sharing of knowledge and best practices.

Communication

A process in which participants create and share information with one another in order to reach a mutual understanding

Communication channel

The means by which messages get from one individual to another

Communities of circumstance

Communities of circumstance are online communities which share the same position, circumstance or life experiences, rather than profession. Communities of position are distinguished from communities of practice in that they tend to be personally focused and do not closely involve the participation of third parties, such as suppliers or customers.

Communities of interest (CoI)

Communities of interest are online communities of people who share a common personal interest or hobby.

Communities of practice (CoP)

Communities of practice are online communities of people who share the same profession, situation, or vocation. These communities facilitate professional exchange, allow members to establish a bond of common experience or challenges.

A view and a working definition of CoP:

1. We can view a community of practice in terms of learning. This approach views learning as an act of membership in a "community of practice."
2. Definition of a CoP as quoted by Stewart (2001): "***A CoP is a group of professionals, informally bound to one another through exposure to a common class of problems, common pursuit of solutions, and thereby themselves embodying a store of knowledge***."

Organisational groups of people that assume roles based on their abilities and skills, instead of titles and hierarchy.

CoP is related to terms such as: Communities of Circumstance / Interest / Position / Purpose.

Communities of purpose

Communities of purpose are online communities of people who are going through the same experience or who are trying to achieve a similar objective. Such communities serve a functional purpose, smoothing the path of the user for the period surrounding a given activity.

Competency management

Competency management is the ability to use knowledge management to consistently facilitate the formation of new ideas, products and services that support the core competency of an organization.

Company – see organization

Compatibility

The degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters

Competitive timing

Whether to attempt to lead or follow in the innovation process

Complementary technologies (inventions)

Innovations that combine with other innovations to create new inventions.

Complexity

1. The degree to which an innovation is perceived as difficult to understand and use
2. The number of alternative possibilities or solutions to a problem or situation

Concept

A pattern of objects or events given a label or the basic idea of something

Content mapping

Content mapping is the process of identifying and organizing a high level description of the meaning contained in a collection of electronic documents. Content maps are usually rendered as hierarchical outlines.

Context sensitivity

Context sensitivity is the ability of a knowledge management system to provide insight that takes into the consideration the contextual nature of a user's request, based on history, associations, and subject experience. See also personalization

CoP – see Community of Practice

Core capabilities

Core capabilities constitute a competitive advantage of a firm and can not be easily imitated.

Corporate amnesia

Corporate amnesia is the loss of collective experience, embedded tacit knowledge and accumulated skills, usually though excessive down-sizing and layoffs.

Corporate memory

Corporate memory is an unquestioned tacit or explicit understanding of an organization's people, process or products.

Customer capital

Customer capital is the value of an organization's relationship with the people with whom it does business.

CRM – see Customer relationship management

Culture

Culture is learned, non-random, systematic behaviour and knowledge that can be transmitted from generation to generation It is also used in a business sense as typical learned, systematic behaviour and knowledge.

Customer capital

The value of an organization's relationships with its customers including the intangible loyalty of its customers to the company or a product, based on reputation, purchasing patterns, or the customers 'ability to pay.

Customer Relationship Management (CRM)

An integrated information system that focuses on the customer and is used for sales, marketing, and customer service activities

DEF

Data

Data is a set of discrete objective facts about events. Data are transformed into information by adding value through context, categorisation, calculations, corrections and condensation. Data are facts and figures without context or interpretation.

Data miner

A data miner is a program that collects information for Web mining, often without the user's knowledge, as spyware.

Data mining

Data mining is sorting through data to identify patterns and establish relationships.

Data mining parameters include:

- Association - looking for patterns where one event is connected to another event
- Sequence or path analysis - looking for patterns where one event leads to another later event
- Classification - looking for new patterns (May result in a change in the way the data is organized but that's ok)
- Clustering - finding and visually documenting groups of facts not previously known
- Forecasting - discovering patterns in data that can lead to reasonable predictions about the future (This area of data mining is known as predictive analytics.)

A technique to analyze data in very large databases. Analysis can reveal trends and patterns and can be used to improve vital business processes.

Declarative Knowledge: Knowing-that.

Knowledge that is in the form of statements about a truth

Deduction

Forming a rule from other rules

Deductive Reasoning

Reasoning in which one is able to discover (or generate) new knowledge, based on beliefs one already holds

Diffusion – see dissemination (our preferred term)

Diffusion of Innovations is also about new knowledge and how it is governed and managed.
When elements of one culture spread to another without wholesale dislocation or migration

Discontinuity of knowledge

Discontinuity of knowledge is the phenomenon which occurs when experienced knowledge workers move from one position to another without having adequate time or knowledge management facilities to transfer their tacit knowledge to colleagues.

Dissemination

The distribution of knowledge objects or artefacts

Document mining

Document mining is a technique to analyze unstructured data in very large document bases (databases containing unstructured documents). Document mining is mostly referred to as text mining because other media are currently still too complex to process.

See text mining

e-brainstorming – See electronic meeting system

e-business

Electronic business is derived from such terms as "e-mail" and "e-commerce". It is the conduct of business on the Internet, not only buying and selling but also servicing customers and collaborating with business partners.

e-learning

Electronic learning is any intentional learning activity delivered via interactive electronic media such as CD-ROMs, DVDs, and the Internet. It includes both synchronous and asynchronous modes of delivery. Specifically used for distance learning which is a formalized teaching and learning system specifically designed to be carried out remotely by using electronic communication.

Electronic collaboration

A process through which project partners can contribute jointly to works in progress via email, groupware, public networks, etc.

Electronic meeting system (EMS)

An EMS is a collection of computer-based tools, each of which can structure and focus the thinking of team members in some unique way.

These systems include tools such as: an idea organizer, electronic voting tools, and electronic brainstorming tools.

EMS – Electronic meeting system

Enablers of knowledge management

Enablers of knowledge management are systems and infrastructures which ensure that knowledge is created, captured, shared, and leveraged. These include culture, technology, infrastructure and measurement.

End user

The final or ultimate user of a computer system. The end user is the individual who uses the product after it has been fully developed and marketed.

Enterprise

The entire business conglomerate networked together as a single operating entity.

e-voting – See electronic meeting system

Experience

Experience refers to what people have done and what has happened to them in the past.

Expert

Specialists in a narrow domain area

Expert system

The branch of artificial intelligence that develops computer programs to simulate human decisions in many fields.

Explicit knowledge

Explicit knowledge is the knowledge that is there for all to find and use in, for example, databases and publications. It can be found in structured repositories and unstructured repositories of knowledge. See also tacit knowledge.

Extensible Mark-up Language (XML)

A subset of Standard Generalized Mark-up language (SGML); is primary an information exchange protocol on Internet technology based networks today. It offers a universal format for the representation and transmission of structured data independent of hardware or software platform, programming or written language, character set, file system, or vendor. It provides the common syntax for web services. XML is extensible, because the mark-up tags are unlimited and self-defining.

Firm – see organization

Framework

A logical structure for classifying and organizing complex information.

A Business Framework is a grid structure where the vertical boxes depict the workflow of core processes, and the horizontal boxes depict business subsystems that control the lifecycles of key business objects. The intersections of core processes with business subsystems form business functions.

The Product Framework shows how the enterprise relates to its customer market.

The Resource Framework shows how the enterprise relates to its supplier market.

GHI

Groupware

Groupware is specialized software that are designed for the use of collaborative work groups. It is a class of software that helps groups of colleagues/workgroups attached to a shared network organize their activities. Typically, groupware supports the following activities:

- Scheduling meetings and allocating resources
- Calendaring
- e-mail
- Electronic newsletters
- File distribution
- Electronic document management (including document routing)
- Electronic faxing
- Groupware is sometimes called:
    - Workgroup productivity software; or

- CSCW - computer supported collaborative work

Help desk

A department within a company that responds to (internal) user's technical questions. Most large software companies have help desks to answer user questions.

Heuristic

Any principle or device that contributes to the reduction in the average search toward a solution.

Human capital

Human capital is the knowledge, skills, and competencies of people in an organization. Unlike structural capital, human capital is owned by the individuals that have it rather than the organization. Human capital is the renewable part of intellectual capital.

That which is in the minds of individuals: knowledge, competencies, experience, know-how etc.

Human capital comprises the capabilities of the individuals required to provide solutions to the people with whom the organization does business.

Hypertext Mark-up Language (HTML)

HTML is a subset of Standard Generalized Mark-up Language (SGML), developed for the semantic tagging of documents. SGML, while very powerful, was difficult to use and never gained wide use. HTML has become the standard for the layout of Web pages displayed within a Web browser. An HTML page contains the text that will appear on the browser, as well as tags or elements that define such Web page attributes as border characteristics, width, colours and other features that affect the appearance of the page on the browser. It is an international standard whose specification is maintained by the Internet Engineering Task Force (IETF).

Incidental Learning

A by-product of exposure to the environment

Individual competence

Refers to the capacity of employees to act in a wide variety of situations. It's their education, skills, experience, energy and their attitudes that will make or break the relationships with the customers and the products or services that are provided. Sveiby uses it instead of Knowledge.

Induction

Forming a general rule from specific examples

Information

Data organized so that it is meaningful to the receiver of the information.

Information is organised / analysed data

Information comprises facts/statistics with context and perspective.

Information retrieval

Information retrieval is the retrieval of information from large collections of unstructured mostly textual documents based on a query language that usually specify keywords and attributed such as author, title, date of publication.

Information and communication technology (ICT)

A term that some people prefer to use instead of IT

Innovation

The process of adopting a new thing, idea, or behaviour pattern into a culture

Innovation is defined as an idea, practice, or product perceived to be new to the adopter

Institution – see organization

Intellectual capital (IC)

Inteelectual capital is the real asset value of the knowledge and experience of an organization s members.

Knowledge that is of value to an organization – made up of human capital, structural capital, and customer capital.

Intellectual capital refers to the commercial value of trademarks, licenses, brand names, formulations and patents.

Intentional Learning

Deliberate attempt to learn

Internet

A global network connecting millions of computers employing common standards for interoperability as well as access and display of multi-media documents

Intranet

A network based on TCP/IP protocols belonging to an organization, usually a corporation, accessible only by the organization s members, employees, or others with authorization.

Invisible assets

Sometimes used as a synonym to intangible assets

JKL

KCM – see knowledge capital management

KDD – see knowledge discovery from databases

Know-How

The ability to cause a desired result. This may be the most valuable Knowledge element of all. It is forward looking and predictive and reflects the person or organizations ability to act and achieve its goals.

This is built on another key Knowledge element "understanding" -what is, what was and why - that deals with knowing historic cause and effect and determining the current state of things.

Knowledge

The notion of “knowledge” is quite complex to define; such as the following definitions show:

Accrued understanding of enterprise related information gained through experience or study.

"Knowledge is, to an enterprise or an individual, the possession of information or the ability to quickly locate it." (www.whatis.com)

Enabler to act.

A validated network and hierarchy of rules. "***What the knower knows***." (Polanyi)

The American Heritage Dictionary defines knowledge as the familiarity, awareness or understanding gained through experience or study.

Knowledge - has several definitions. In the dictionary definitions the term knowledge is:

The American Heritage Dictionary defines knowledge as the familiarity, awareness or understanding gained through experience or study.

- A clear and certain perception of something
- Understanding
- Learning
- All that has been perceived or grasped by the mind
- Practical experience and skill
- Acquaintance or familiarity
- Cognizance; recognition
- Organized information applicable to problem solving
- Knowledge is actionable information

Knowledge is information which provides guidance for action. It comprises a fluid mix of experiences, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experience and information. It originates and is applied in the mind of the knower. In organizations, it often becomes embedded not only in documents or repositories but also in organisational routines, processes, practices and norms. Key related concepts are experience, truth, judgement, and rules of thumb.

See also declarative and procedural knowledge

Knowledge base

The accumulation of business-related information stored within a special database.

The hierarchical network of an agent's validated rules is the knowledge base of that agent. There are two kinds of validated rule networks: Explicit and tacit. Explicit knowledge bases are rules sets that are identified, communicated, and usually codified for other agents to share. Tacit knowledge bases are unidentified and unwritten and are usually communicated non-verbally.

An organized structure of information which facilitates the storage of intelligence in order to be retrieved in support of a knowledge management process

Knowledge capital management (KCM)

Synonym for management of assets such as intellectual capital

Knowledge channels

Specific collections of problem-solution pairs, diagnostics, illustrations, technical articles, and reference documents pertaining to software and hardware products within RightAnswers.com.

Knowledge creation

Knowledge creation is a knowledge process where knowledge is created from organizational learning in response to new business challenges or innovation

Knowledge database – see Knowledge base

Knowledge discovery

Knowledge discovery is one of the two key KM applications. It involves techniques and technologies that discover knowledge in large collections of data (data mining) and text databases (text mining) as well as other multi-media documents. Patterns of knowledge which are usually unknown are analysed and exposed.

Knowledge discovery from databases (KDD)

See knowledge discovery

Knowledge ecology

Knowledge ecology deals with the entire microcosm of interacting agents and resources in equilibrium.

Knowledge economy

An environment where knowledge claims competes against each other with each other for a place in the organizational knowledge base.

Knowledge engineer

Communicates with experts to acquire relevant knowledge

Knowledge leadership

Knowledge leadership represents a broad category of positions and responsibilities in organizations, including knowledge managers and chief knowledge officers.

Knowledge management is approached in three different ways. Firstly and most simply, it is seen as an approach to making an organization's knowledge stores more successful and useful.

It is also a business activity with two primary aspects: treating the knowledge component of business activities as an explicit concern of business reflected in strategy, policy and practice at all levels of the organisation and making a direct connection between an organisations intellectual assets, both explicit and tacit, and positive business results.

In addition, it is also seen as a conscious strategy of getting the right knowledge to the right people at the right time, and helping people share and put information into action in ways that strive to improve organisational performance.

Knowledge management (KM)

The discipline designed to identify, manage and share all of an enterprise's information assets. These assets may include existing knowledge in databases and expertise of individual employees. Knowledge management also includes developing, implementing and maintaining technical and organizational infrastructures that support knowledge sharing throughout the enterprise.

KM is essentially the management of knowledge processes.

The systematic process of finding, selecting, organizing, distilling and presenting information in a way that improves an employee's comprehension in a specific area of interest.

Explicitly or implicitly affecting the processes an agent or collective of agents use to discover, create, use, change, transfer, store, or replace their internal and external validated rule sets.

Knowledge management technologies – KM technologies

KM technologies are a set of IT and other technologies that are utilised as enablers for managing knowledge processes.

Knowledge mapping

Knowledge mapping comprises a process which provides and organisation with a picture of the specific knowledge it needs in order to support its business processes.

Knowledge Object

A well-defined set of rules bundled with a concept

Knowledge portal – (K-portal)

A K-portal is a software portal specifically designed to assist knowledge workers.

Knowledge Processes

The set of processes occurring in an organization to create, refines, use, retrieve, extract and transfer knowledge

Knowledge representation

Knowledge representation is a central problem in arranging knowledge. Various AI techniques were developed and include three schemas: case-based reasoning (CBR), rule-based systems (RBS), and model-based reasoning (MBR). The three most used techniques for knowledge representation are semantic networks, frames, and scripts.

Knowledge rules

Validated rules of agents. The knowledge rule network is the validated set of rules from the viewpoint of the agent s or a collective of agent s validation criteria, not just any network of rules.

Knowledge sharing

Knowledge sharing is part of the knowledge process "knowledge sharing and transfer" and involves the sharing of knowledge between knowledge workers.

Knowledge System

A computer system that represents and uses knowledge to carry out its task

Knowledge types

Know-what - refers to knowledge about facts or some truth; also known as declarative knowledge

Know-why – refers to knowledge about principles and laws in nature, the human mind, and society. It involves deep knowledge of cause-and-effect relationships.

Know-how – refers to skills – i.e. the ability to do something; that is to apply "know-what" knowledge to complex real-world problems.

Know-how – involves information about who knows what and who knows what to do.

Know-when – refers to knowledge involving timing.

Knowledge varieties

Explicit knowledge as represented in databases, memos, notes, documents, etc.

Imbedded knowledge which is encountered in business rules, processes, manuals, in the organization's culture, codes of conduct and ethics, etc.

Tacit knowledge which is present in the minds of human stakeholders

Learning organization

"***A learning organisation is an organisation skilled at creating, acquiring, and transferring knowledge, and at modifying its behaviour to reflect new knowledge and insights***." – Garvin (1993)

Learning organizations are where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together. The concept originated from Peter Senge's 1990 book ***The fifth discipline: the art and practice of the learning organization***. See also the related terms mental models, team learning, systems thinking and personal mastery.

See also: organizational learning

MNO

Mental models

Mental models are deeply ingrained assumptions, generalisations, or even pictures or images that influence how individuals understand the world and take action.

Meta-knowledge

Knowledge about the very nature of knowledge and knowing

Meta-knowledge portal

Source of knowledge about knowledge

Meta-learning

Learning about the nature of learning

Meta-portal

Portal used to manage other portals based on meta-rules

Natural Language Processing (NLP)

Processing done by computers while handling (and aiming to "understand") natural human language

Neural Network (NN)

A form of artificial intelligence in which a computer simulates intelligence by attempting to reproduce the types of physical connections that occur in animal or human brains

NLP – See Natural language processing

NN – Neural network

Notion | idea | concept

These basic terms are treated here as synonyms.

Online analytical processing (OLAP)

See business intelligence

Organization (Collective Pattern)

Groups and teams with a common identity with other groups to achieve a common goal from organization collective patterns

Organization | company | firm | institution – treated here as synonyms

Organizational learning

Responding to the complexity and uncertainty of a rapid changing environment as a collective organization

See also: Learning organization

Ontology

In computer science, an ontology is the attempt to formulate an exhaustive and rigorous conceptual schema within a given domain, a typically hierarchical data structure containing all the relevant entities and their relationships and rules (theorems, regulations) within that domain.

PQR

Paradigm

An example, model, pattern or standard

Peer assist

Peer assist is a meeting or workshop where people are invited from other teams within an organization to share their experience.

Personal information manager (PIM)

Personal mastery

Personal mastery is the discipline of continually clarifying and deepening an individual's personal vision, focusing energies, developing patience, and trying to see reality objectively in order to live life in the service of the individual's highest aspirations.

Pattern

Something stable and repeatable; is capable of being copied where the copies are similar to the original

Procedural knowledge: Knowing-how

Knowledge that is in the form of procedural rules. This is the most fundamental form of knowledge

Process (behaviour pattern)

A set of sequential tasks performed to fulfil a specific, measurable goal-state. Processes are value streams in that they are oriented toward producing, and do produce, value for the enterprise, and for the agents who use the process.

Processes

Sets of documented steps with clearly defined roles and activities for people to perform

Internal key CoP processes include: managing the community's intellectual capital, sharing tacit knowledge, communication, socialization, membership management, and content management

External CoP processes include: incentive recognition, business strategy development and execution, and competency development

Relationship capital (or Customer capital)

Relationship capital is the value of the organisation's relationships with the people with whom it does business including clients, market participants, and suppliers.

Replication

The repeated duplication of events, processes, or databases.

Rules of thumb

Rules of thumb are shortcuts to solutions to new problems that resemble problems previously solved by experienced workers. Sometimes used as synonym of "heuristics"

STU

SCM – see supply chain management

Self-help

Putting the problem and answers on the web or intranet and empowering users to solve their own issues to gaining momentum

Semantic Web

The Semantic Web is a project that intends to create a universal medium for information exchange by giving meaning, in a manner understandable by machines, to the content of documents on the Web.

Skill learning

Associated with procedural knowledge

Socialization

The process by which a person acquires the technical skills of his or her society, the knowledge of the kinds of behaviour that are understood and acceptable in that society, and the attitudes and values that make conformity with social rules personally meaningful, even gratifying; also termed enculturation.

Structural capital

The processes, structures, information systems, and patents that remain with a company when employees leave

Processes, information systems, databases, patents, etc.

Structured repositories of knowledge

Structured repositories of knowledge comprise databases, expert systems, and the like. They are characterised by their ease of search ability.

See also unstructured repositories of knowledge.

Subject matter expert (SME)

A professional who has in-depth knowledge and experience in a particular discipline / subject

Supply chain management (SCM)

SCM are systems that "surround" the factory and provide an operational OLTP environment that typically covers purchasing, order entry, materials management, distribution, and warehousing. It is the B2B side of e-business. See e-business

Systems thinking

Systems thinking is a conceptual framework, a body of knowledge and tools that have been developed over the past 50 years, to make the full patterns clearer, and to make it possible to bring about effective change with the least amount of effort by finding the leverage points in a system. See also learning organizations.

Taxonomy

A system of categorising information

Team learning

Team learning starts with 'dialogue', the capacity of members of a team to suspend assumptions and enter into a genuine 'thinking together'. Team learning is vital because teams, not individuals, are the fundamental learning unit in modern organizations. Unless teams can learn, the organization cannot learn.

Tacit knowledge

Tacit knowledge is unspoken, non-codified knowledge. It is usually lockup in individual skills, routines, and experience. Tacit knowledge resides in people's heads.

See also explicit knowledge.

Technology

The application of science and the body of information system knowledge that we use to fashion tools, practice knowledge arts and extract data and information.

It includes a wide variety ranging from tried-and-true tools and techniques to groundbreaking and innovative experiments.

Text mining

Text mining is a set of technique to analyze unstructured text in very large text document bases (databases containing unstructured text). Text mining is mostly concerned with analysis of text such as feature extraction, topic analysis, language recognition, and text summary.

See also document mining

Thesaurus

A structured set of terms related according to relations such as “narrower-than”, “broader-then”, “see-also”, “synonym-of”, etc.

UML

Unified Modelling Language is a modelling language used for object-oriented software development developed by the Object Management Group.

Unstructured repositories of knowledge

Unstructured repositories of knowledge include project reports and other non-indexed sources of information.

See also structured repositories of knowledge.

VWXYZ

Voice over Internet Protocol (VoIP)

A category of hardware and software that enables people to use the Internet as the transmission medium for telephone calls.

Web

A system of Internet servers that support specially formatted documents. The documents are formatted in the mark-up language HTML (HyperText Mark-up Language) that supports links to other documents, as well as graphics, audio, and video files.

Web mining

Web mining is a type of data mining used in customer relationship management (CRM), taking advantage of the huge amount of information gathered by a Web site to look for patterns in user behaviour.

Wisdom

Wisdom is understanding which knowledge to use for what purpose.

Workflow

The defined series of tasks within an organization to produce a final outcome

See also BPM

Workflow automation – see also Business Process Management

XML – See extensible mark-up language

XSL – See extensible style sheet language

End of Glossary

Appendices

Knowledge is in the mind of the beholder and

KM is in the mind of the beholder or strategist. – Author

Table of Contents

Appendix A: Other Works Consulted and KM Reference Sources

The following references and works were also consulted or checked although not directly referenced per se. The KM field incorporates a large number of web sites and available online material. As all researchers know beforehand a (too) large number of these are not explicitly date-stamped which limit their credibility but a number of these are still valuable for insight and stimulation of ideas. Others are becoming somehow dated. We list here directly accessed sites and material utilised during the completion of this study as well as some general sites on KM.

A.1 Some Additional Material on KM

1. V. Allee (1997): "***The Knowledge Evolution: Expanding Organisational Intelligence***", Butterworth-Heinemann.
2. A. Brooking (1996): "***Intellectual Capital***", International Thompson Business Press.
3. T. Davenport (1997): "***Secrets of Successful Knowledge Management***", Knowledge Inc, online at: http://webcom.com/quantera/Secrets.html
4. C. Holsapple (ed) (2002): "***Handbook on Knowledge Management***", Springer Verlag, Heidelberg
5. J. Kluge, W. Stein and T. Licht (2001): "***Knowledge Unplugged: The McKinsey & Company Global Survey on Knowledge Management***", by Palgrave, New York
6. Lucier C. and Torsilieri J., (1997), "***Why Knowledge Programs Fail: A C.E.O.'s Guide to Managing Learning***", online at: http://www.strategybusiness.com/strategy/97402/page1.html
7. Y. Malhotra (1996): "***Organisational Learning and Learning Organisations: An Overview***", online at: http://www.brint.com/papers/orglrng.htm
8. Y. Malhotra (1998): "***Knowledge Management for the New World of Business***", online at: http://www.brint.com/km/whatis.htm
9. B. Manasco (ed) (?): "***Leading Firms Develop Knowledge Strategies***", Knowledge Inc., online at: http://webcom.com/quantera/Apqc.html
10. B. Manasco (ed) (?): "***Rediscovering our Customers and the Knowledge they Possess***", Knowledge Inc., online at: http://webcom.com/quantera/empires4.html
11. B. Manasco (ed) (?): "***Customer Relationships that can Last a Lifetime***", Knowledge Inc., online at: http://webcom.com/quantera/Empires1097.html
12. D. Morey, M. Maybury and B. Thuraisingham (eds) (2000): "***Knowledge Management: Classic and Contemporary Works***", Cambridge, MIT Press
13. C. O'Dell (1998): "***The Value of Knowledge Management***", online at: http://corpr.unisys.com/execmag/1998-03/journal/viewpoints1.htm
14. K-E. Sveiby (2001): "***KM – Lessons from the Pioneers***", Karl-Erik Sveiby web site, November 2001

15. K-E. Sveiby and R. Simons (2002): "***Collaborative Climate and Effectiveness of Knowledge Work – an Empirical Study***", final draft July 2002, accepted for publishing in Journal of Knowledge Management Vol. 6 No. 5. November 2002; published version available at https://www.emeraldinsight.com/1367-3270.htm
16. The Technology Guide Series (2000): "***Strategic Benefits of Knowledge Management***", The Technology Guide Series, www.techguide.com online accessed in 2001
17. K. Wiig (1993): "***Knowledge Management Foundations - Thinking about Thinking: How People and Organizations Create, Represent, and Use Knowledge***", Arlington, TX: Schema Press

A.2 Online KM Web Sites and Internet Sources

http://bprc.warwick.ac.uk/index.html Business Processes Resource Center
http://carbon.cudenver.edu/~mryder/itc_data/org_learning.html Organizational Learning and KM
http://datamanagement.about.com/ Data / Content Management and Portals
http://emaraldinsight.com/jkm.htm Journal of Knowledge Management
http://km.gwu.edu/km/index.cfm George Washington University
http://kmi.open.ac.uk/home-f.html Knowledge Media Institute
http://knowledgemanagement.ittoolbox.com/ KM at IT toolbox
http://ksi.cpsc.ucalgary.ca/KSI/ Knowledge Science Institute
http://mitsloan.mit.edu/smr/index.html MIT Sloan Management Review
http://www.andypryke.com/university/TheDataMine.html The Data Mine
http://www.apqc.org/km American Productivity and Quality Center
http://www.BambooWeb.com – A web site with remarkably rich intellectual capital
http://www.bl.com.au/km/ Knowledge management leadership forum (AU)
http://www.bpubs.com/Management_Science/Knowledge_Management/ Business Publications
http://www.brint.com/ **Brint, the largest KM portal!**
http://www.bus.utexas.edu/kman/ The University of Texas Knowledge Management
http://www.cio.com/research/knowledge CIO Magazine KM research center
http://www.collaborate.com/ Groupware and Knowledge Management
http://www.css.edu/users/dswenson/web/KMhoem.htm KM Home
http://www.destinationcrm.com/km/dcrm_km_index.asp KM @ destination CRM.com
http://www.destinationkm.com KM Magazine
http://www.eknowledgecenter.com/ e-Knowledge Center
http://www.ewenger.com/ Web site of Etienne Wenger
http://www.factiva.com/infopro/ Factiva's information portal
http://www.fastcompany.com/homepage/ Fast Company
http://www.fend.es/ Federation for Enterprise Knowledge Management
http://www.gurteen.com The Gurteen knowledge Website
http://www.hyperwords.net

http://www.icasit.org/km/ ICASIT KM Center
http://www.intranetjournal.com/ Intranet Journal
http://www.kesummit.com/Solve1.pdf Valuation
http://www.km.gov The Federal KM Home Page
http://www.kmarea.com/
http://www.KMbook.com/
http://www.kmetasite.org/ This "site of sites about km" is maintained at ITESM, Mexico
http://www.km-forum.org/ The KM Forum
http://www.kmmagazine.com/home/default.htm KM Magazine
http://www.kmnetwork.com (http://www.brint.com/km) KM virtual library
http://www.kmnews.com/ KM News
http://www.kmol.online.pt/ajuda/english.html KMOL
http://www.kmresource.com/ KM Resource Center
http://www.km-review.com/ KM Review
http://www.kmsoftware.com/ KM software
http://www.kmworld.com/ KM World
http://www.knowinc.com/ Know Inc
http://www.knowledge.org.uk/default.htm Knowledge on-line
http://www.knowledge.standards.com.au/ Knowledge standards (AU)
http://www.knowledgeboard.com/index.html Knowledge Board (UK)
http://www.knowledgebusiness.com The Knowledge Network
http://www.knowledgeinc.com/
http://www.knowledge-management.com
http://www.knowledgemanagement.com.au/default.asp Knowledge Mangement
http://www.knowledgemedia.org/ NetAcademy on Knowledge Media
http://www.knowledge-nurture.com
http://www.knowledgepoint.com.au/index.htm Knowledge point (AU)
http://www.knowledge-portal.com
http://www.knowledgereasecrh.com/ Knowledge Research Institute
http://www.knowledgeshop.com/
http://www.know-net.org
http://www.ktic.com/ KM Metazine; Learning solutions
http://www.kwork.org/ AOK
http://www.liquidinformation.org
http://www.lotus.com/home.nsf/welcome/km/ KM and Lotus Notes Case Studies
http://www.lti-portal.org/ LTI (Europe)
http://www.macroknowledge.com/ Macroknowledge
http://www.metakm.com/index.php Meta KM portal
http://www.mitre.org/pubs/edge/april_00/index.htm Special Issue on KM
http://www.mitre.org/resources/centers/it/maybury Tutorial: Introduction to KM

http://www.mitre.org/work/knowledge_mgt.shtml MITRE Corporation KM site
http://www.mjm.co.uk/knowledge/index.html The International KM Newsletter
http://www.quotations.about.com
http://www.research.ibm.com/journal/ IBM Systems Journal; IBM IT research articles
http://www.research.ibm.com/thinkresearch/ IBM Think Research Magazine
http://www.serviceinnovation.com/
http://www.skyrme.com.kmres.htm David Skyrem's Links to KM Sites
http://www.sveiby.com Karl-Erik Sveiby's web site
http://www.techguide.com Web site with many technology-related intellectual capital
http://www.totalkm.com/index.html Total KM (India)
http://www.transformmag.com/ Content management and collaboration
http://www.uni-hohenheim.de/~miepple/ikcenter.html KM research papers and publications
http://www-ksl.stanford.edu/knowledge-sharing/README.html ARPA Knowledge Sharing Effort

A.3 Sveiby's View of Knowledge Management

Karl-Erik Sveiby is a well-respected academic and practitioner in the KM field. His approach to defining KM is to observe what people in the field of KM are doing. He maintains that there seems to be two tracks of activities – and two levels. The following extract comes from the article of Sveiby (2001a), namely: "***What is Knowledge Management?***"

"**IT-Track KM = Management of Information**. Researchers and practitioners in this field tend to have their education in computer and/or information science. They are involved in construction of information management systems, AI, reengineering, groupware etc.
To them Knowledge = Objects that can be identified and handled in information systems.

This track is new and is growing very fast at the moment, assisted by new developments in IT.

People-Track KM = Management of People. Researchers and practitioners in this field tend to have their education in philosophy, psychology, sociology or business / management. They are primarily involved in assessing, changing and improving human individual skills and/or behaviour. **To them Knowledge = Processes**, a complex set of dynamic skills, know-how etc, that is constantly changing. They are traditionally involved in learning and in managing these competencies individually – like psychologists – or on an organisational level – like philosophers, sociologists or organisational theorists.

This track is very old, and is not growing so fast.

Level: Individual Perspective. The focus in research and practice is on the individual.

Level: Organisational Perspective. The focus in research and practice is on the organisation.

A 2x2 grid might look like this:

	Knowledge Management	
Track / Level	**IT-Track** **Knowledge = Object**	**People-Track** **Knowledge = Process**
Organization Level	"Re-engineers"	"Organization Theorists"
Individual Level	"AI-specialists" "e-specialists"	"Psychologists"

Even if this grid is to oversimplify things, it captures one essential issue: There are paradigmatic differences in our understanding of what **knowledge** is.

The researchers and practitioners in the "Knowledge = Object" column tend to rely on concepts from Information Theory in their understanding of Knowledge.

The researchers and practitioners in the column "Knowledge = Process" tend to take their concepts from philosophy or psychology or sociology.

Because of their different origins, the two tracks use different languages in their dialogues and thus tend to confuse each other when they meet.

Personally I dislike the notion "Knowledge Management". Knowledge is a human faculty, not something that can be "managed", except by the individual him/herself. A better guidance for our thinking is therefore phrases such as "***to be Knowledge Focused***" or to "see" the world from a "***Knowledge Perspective***". To me Knowledge Management is: ***The Art of Creating Value from Intangible Assets***.

Following the matrix above I would label myself an "Organisation Theorist". My own managerial experience and research are in how managers of organisations which produce and sell only knowledge manage their intangible assets. I call them "Knowledge Organisations", and I have used epistemology for understanding what knowledge is."

Appendix B: Other Knowledge Management Principles

For interest sake we included here three lists of KM Principles from V. Allee, C. O'Dell and C. J. Grayson, and T. Tobin.

B.1 KM Principles of Allee

Sourced from Allee (1997):

1. Knowledge is "messy."
2. Knowledge is self-organizing.
3. Knowledge seeks community.
4. Knowledge travels on language.
5. Knowledge is slippery.
6. Looser is probably better.
7. Knowledge keeps changing.
8. Knowledge does not grow forever--something eventually dies or is lost.
9. No one is really in charge.
10. You cannot impose rules and systems
11. There is no silver bullet
12. How you define the knowledge "problem" determines what and how you try to manage.

B.2 KM Principles of O'Dell and Grayson

Sourced from O'Dell and Grayson (1998) chapter 22:

1. Business values drive transfer benefits
2. Transfer of best practices is the most common, and most effective, KM strategy
3. KM must be woven into the corporate infrastructure
4. KM-earmarked funding is rare
5. Having the "Right" culture is critical
6. Successful KM efforts employ a "Push-Me-Pull-You" approach
7. If it works, it really works
8. Top-level support is a must
9. Technology is a catalyst but no panacea
10. Mature KM efforts lead to transition from nurturing to measuring

B.3 KM Principles of Tobin

Sourced from Tobin (2003):

1. Knowledge Management is a discipline
2. One champion is not enough
3. Cultural change isn't automatic
4. Create a change management plan
5. Stay strategic
6. Pick a topic, go in-depth, keep it current
7. Don't get hung up on the limitations
8. Set expectations or risk extinction
9. Integrate KM into existing systems
10. Educate your self-service users

Appendix C: History of the Study of Knowledge Management

The following overview of the history of the study of KM was sourced and is an extract from eKnowledgeCenter.com:

"**In Science:**

Late 1880s – Franz Boas, the founder of modern anthropology, studied knowledge production and diffusion within and between cultures, known as cultural cognition. Other anthropological studies in this area include those by Emile Durkheim, Ruth Benedict, Margaret Mead, among others.

Early 1900s – Joseph Schumpeter introduced the input of knowledge to the classical economic model demonstrating that economic growth is dependent on technological change.

1936-1960 – Though Karl Mannheim created the field of Sociology of Knowledge in 1936, Robert Merton expanded it into the form it is today. This field is best summarized in his 1945 paper, "***Paradigm for the Sociology of Knowledge***," in which he describes the forces in science and society that govern knowledge, namely:

Social bases: social position, class, generation, occupational roles, mode of production, group structures (university, bureaucracy, academies, sects, political parties, society, ethnic affiliation, social mobility, power structure, social processes (competition, conflict, etc.)

Cultural bases: values, ethos, climate of opinion, type of culture, culture mentality

Spheres of: moral beliefs, ideologies, ideas, the categories of thought, philosophy, religious beliefs, social norms, positive science, technology

Reasons for: to maintain power, promote stability, orientation, exploitation, obscure actual social relationships, provide motivation, canalize behaviour, divert criticisms, provide assurance, control nature, coordinate social relationships, etc.

1957 – Economist Herbert Simon coined the term, "***Organizational Learning***," and challenged the "***rational man***" concept in economics.

1957 – Michael Polanyi introduced the concept of ***tacit knowledge*** and the importance of tacit knowledge.

1962 – Economist Kenneth Arrow established the concept of "learning by doing" as a way organizations generate knowledge and the "***learning curve***" as a way to measure the cost of knowledge diffusion.

1969 – Economist Robert Solow provided a convincing argument that new knowledge is the key factor to economic growth.

1966 – Thomas Kuhn revealed how scientific knowledge evolves as a series of revolutions influenced by sociological forces.

1970s – Several cognitive scientists focused on social cognition versus individual cognition. In 1997, the first Robo Soccer/ RoboCup tournament was played in Japan to test social cognition theories. Herbert Simon helped sponsor this area of research.

1976 – John Holland introduced a mathematical framework that is used today as a model to measure the effectiveness of KM.

1978 – Nathan Rosenberg added to Kenneth Arrow's work "***learning by using***" - generating knowledge by using a product.

1980s – The diffusion of Information and Communications Technology forced the world into an Information Economy by reducing the cost of access to information.

1980s – Laboratories, hospitals, and businesses realized the benefits of computer-based knowledge systems. Expert systems, automated knowledge acquisition, and neural nets began to capture expert knowledge to help users of the system diagnose problems.

1982 – Nelson and Winter developed the ***Evolutionary Economic Theory*** that demonstrated how including knowledge as a factor in economics can improve the accuracy of an economic model.

1986 – Karl Wiig from Arthur D. Little coined the word "***Knowledge Management***" in an article about the use of artificial intelligence in helping people manage knowledge.

1990s – Economist Paul Romer introduced ***New Growth Economics*** accounting for new knowledge and technological change.

1996 – OECD issued a report called ***The Knowledge-Based Economy*** and warned countries that they need to learn how to manage a knowledge-based economy or fall behind.

1998 – United Nations sponsored a report on ***Knowledge Societies: Information Technology for Sustainable Development***

In Business:

1960s – In a study about AT&T, Alvin Toffler discussed the need to shift from "***Handcraft***" to "***Headcraft***" to become an adaptive corporation and keep the procedural manuals fluid.

1960s – Peter Drucker coined the term "***Knowledge Worker***."

1990 – Peter Senge coined the term "***Learning Organization***," and his book, ***The Fifth Discipline***, became one of the most influential books in business.

1991 – Ikujiro Nonaka and Hirotaka Takeuchi published ***The Knowledge Creating Company*** and introduced the concepts of "***Ba***" and "***knowledge conversion cycle***". For most, this is the book that helped diffuse the notion of knowledge management to the business community.

1993 – Peter Drucker (in ***Post Capitalist Society***) introduced the emergence of a "***knowledge society***."

1997 – Business Week, Forbes, the Wall Street Journal, and other business publications started publishing articles on the importance of KM for business strategy.

During the 1990s, software vendors and consulting firms started packaging KM around their products causing great confusion."

Appendix D: Philosophers and their Ideas about Knowledge

D.1 Plato’s Theory of Ideas and on True Knowledge

In this section make brief extracts form the viewpoints of the modern-day philosopher Jostien Gaarder about the philosopher Plato and his ideas of knowledge and the world. Plato’s ideas still have a large influence on our modern world views. We include here extracts from Jostien Gaarder’s 1996 book “***Sophie’s World***” which covers the history of philosophy.

D.1.1 Plato’s Theory of Ideas

“He (Plato) was astonished at the way all natural phenomena could be so alike, and he concluded that it had to be because there are a limited number of forms ‘behind’ everything we see around us. Plato came to the conclusion that there must be a reality behind the ‘material world.’ He called this reality the world of ideas; it contained the eternal and immutable ‘patterns’ behind the various phenomena we come across in nature. This remarkable view is known as Plato’s theory of ideas.”

D.1.2 Plato on True Knowledge

“A philosopher tries to grasp something that is eternal and immutable. …
Plato believed that everything we see around us in nature, everything tangible, can be likened to a soap bubble, since nothing that exists in the world of the senses is lasting. …
Plato’s point is that we can never have true knowledge of anything that is in a constant state of change. We can only have opinions about things that belong to the world of the senses, tangible things. We can only have true knowledge of things that can be understood with our reason.”
…
“Plato believed that reality is divided into two regions.

“One region is the world of the senses, about which we can only have approximate or incomplete knowledge by using our five (approximate or incomplete) senses. In this sensory world, ‘everything flows’ and nothing is permanent. Nothing in the sensory world is there are only things that come to be and pass away.

“The other region is the world of ideas, about which we can have true knowledge by using our reason. This world of ideas cannot be perceived by the senses, but the ideas (or forms) are eternal and immutable”

D.2 Michael Polanyi

In this section we included condensed remarks about the viewpoints of the philosopher Michael Polanyi who has had (and still has) a huge influence on the perspectives and theoretical basis of knowledge and knowledge management. We mainly cover his ideas drawn from the descriptions of the following sources which we mostly quote as extracts in the following. The sources from which we extracted material (with our own highlighting) are:

1. http://www.BambooWeb.com – A web site with useful and rich intellectual capital
2. K-E. Sveiby (2001b): "A ***Knowledge-based Theory of the Firm; To guide Strategy Formulation***"
3. K-E. Sveiby (1997b): "***Tacit Knowledge***" available online at: http://www.sveiby.com/index.html

Sourced from: http://www.BambooWeb.com

"Management theory functions as a branch of economics, and to a large extent it adopts econometric standards. When it became apparent that it would be useful to be able to manage knowledge, it was natural for managers to attempt to apply their preferred econometric methods to the cause. But econometrics is about commodities and cash flow. It found it therefore necessary to treat knowledge as if it were a commodity.

"This, of course, was a surprisingly difficult thing to do, essentially because knowledge is not a commodity but a process. But a suitable epistemology was found, in the form of that developed by Michael Polanyi. Polanyi's epistemology objectified the cognitive component of knowledge – learning and doing – by labelling it tacit knowledge and for the most part removing it from the public view. Learning and doing became a 'black box' that was not really subject to management; the best that could be done was to make tacit knowledge explicit."

Sourced from: K-E. Sveiby (2001b)

"Venzin, Krogh and Roos (1998) make a distinction between three epistemologies that may guide practice and research under an epistemological perspective: the **cognitivist**, ... the **connectionist** ... and the **autopoietic** ... The cognitivist perspective assumes organisations to be open systems, which develop knowledge by formulating increasingly accurate "representations" of the world. The more data and information organisations can gather the closer the representation will be. Hence most cognitivist perspectives equate knowledge with information and data.

"According to the connectionist epistemology the organisation still "represents" its outside world, but the process of representation of reality is different. As in cognitivist epistemology information processing is the basic activity of the system.

"Autopoietic epistemology provides a fundamentally different understanding of the input to a system. Input is regarded as data only. Knowledge is private, a notion which comes close to (Polanyi's,1958) concept of "personal" knowledge. Autopoietic systems are both closed and open. Open to data, but closed to information and knowledge, both of which have to be interpreted inside the system. Autopoietic systems are self-referring; the world is not seen as fixed and objective. It is constructed within the system and it is therefore not possible to "represent" reality. An organisation can be seen as a group of individuals who have created an emergent common frame of reference.

"Both (Nonaka & Takeuchi, 1995) and (Sveiby, 1997) come close to an autopoietic epistemology even if neither authors build their foundations on autopoeisis. Building on Plato and arguing against the Descartian body/mind spit, (Nonaka & Takeuchi, 1995) ... define knowledge as a justified true belief: When somebody creates knowledge, he or she makes sense out of a new situation by holding justified beliefs and committing to them. ...
The emphasis in this definition is on the conscious act of creating meaning."[1]

Sourced from: K-E. Sveiby (1997b)

"Michael Polanyi (1891-1976) was a Hungarian medical scientist whose research was mainly done in physical chemistry before he turned into philosophy at the age of 55. He accepted a personal chair in social studies at the University of Manchester in 1948. His lectures were collected in his opus magnum Personal Knowledge, Towards a Post Critical Epistemology in 1958. Although very influential in the background he was never recognised as a "true" philosopher by his contemporaries.

"Tacit Knowledge is of particular interest for those who are interested in how to manage Knowledge Organizations or those involved in Intellectual Capital.

"The concept also explains some of the paradoxes on the Information Markets. Michael Polanyi called his book ***Personal Knowledge*** because he wanted to underline that the intellect also in science is connected with a "passionate" contribution of the person knowing. Emotions are a vital component of the person's knowledge. But this does not make our understanding subjective.

"Knowing is objective in the sense of establishing contact with a hidden reality.

"Main Theses
"Polanyi`s concept of knowledge is based on three main theses: First, true discovery, cannot be accounted for by a set of articulated rules or algorithms. Second, knowledge is public and also to a very great extent personal (i.e. it is constructed by humans and therefore contains emotions,

[1] Sveiby (1997) mentioned here refers to Sveiby (1997a)

"passion"). Third, the knowledge that underlies the explicit knowledge is more fundamental; all knowledge is either tacit or rooted in tacit knowledge.

“Knowledge is thus not private but social. Socially conveyed knowledge blends with the experience of reality of the individual.

“Both Quantum Mechanics and the theory of relativity are very difficult to understand; it takes only a few minutes to memorize the facts accounted for by relativity, but years of study may not suffice to master the theory and see these facts in its context. At all (these) points the act of knowing includes an appraisal; and this personal coefficient, which shapes all factual knowledge, bridges in doing so the disjunction between subjectivity and objectivity.

“New experiences are always assimilated through the concepts that the individual disposes and which the individual has inherited from other users of the language. Those concepts are tacitly based. All our knowledge therefore rests in a tacit dimension.

“When we are tacitly involved in a process-of-knowing we act without distance. This describes how and why we take things "for granted". The individual changes, "adapts", the concepts in the light of experiences and reinterpret the language used. When new words or concepts are brought into an older system of language, both affect each other. The system itself enriches what the individual has brought into it.

“Tacit and Focal Knowledge

“In each activity, there are two different levels or dimensions of knowledge, which are mutually exclusive: Knowledge about the object or phenomenon that is in focus - <u>focal knowledge</u>. Knowledge that is used as a tool to handle or improve what is in focus - <u>tacit knowledge</u>.

“The focal and tacit dimensions are complementary.

...

“Action Oriented

“Polanyi`s theory is about how human beings acquire and use knowledge, it is action oriented and about the process of knowing. In his earlier works he frequently uses the verb "knowing" and the noun "knowledge" as synonyms. In his later works (Tacit Knowing) he emphasises the dynamic properties, i.e. the verb: Knowledge is an activity which would be better described as a process of knowing. Polanyi thus regards knowledge as both static "knowledge" and dynamic "knowing". When the dynamic properties are emphasised, He uses verbs like knowing or learning. The dynamic properties describe how human beings strive for acquiring, coming to know, new knowledge.

"Subsidiary awareness and focal awareness are mutually exclusive. If a pianist shifts the attention from the piece he is paying to the observation of what he is doing with his fingers while playing it he gets confused and may have to stop.

"When I read an article or book I am vividly aware of the meaning conveyed by the text, still I may know none of its words. I have attended to the words but only for what they mean to me and not as the objects they are. The message of a letter is therefore remembered even after the symbols of the text is forgotten. I might not even remember what language it was written, if I know several languages.

"Polanyi emphasises that the human being is knowing all the time, we are switching between tacit knowing and focal knowing every second of our lives, it is a basic human ability to blend the old and well-known with the new and unforeseen, otherwise we would not be able to live in the world.

"Articulated Knowledge

"Polanyi also sometimes describes knowledge as an object that can be articulated in words. When tacit knowledge is made explicit through language it can be focused for reflection.

...

"By distancing the actor from the knowledge and articulate it in language or symbols, the knowledge becomes possible to distribute, criticise and thereby increase.

"Polanyi`s emphasis on the dynamic properties makes articulate propositionary knowledge (facts) - metaphorically speaking - only the top of the iceberg.

"Because we can know more than we can tell it follows that what has been made articulate and formalised is in some degree underdetermined by that of which we know tacitly. Language alone is not enough for making knowledge explicit.

...

"Knowledge is a Tool with Rules

"Polanyi also emphasises the functional aspect of knowledge, i.e. he regards knowledge as a tool by which we either act or gather new knowledge. This tool is un-reflected knowledge that we take for granted in a situation.

...

"To Know is to Do

"The medical diagnostician's skill is as much an art of doing as it is an art of knowing.

"Intellectual tools are however different from physical tools in that they are based in a social context. A person needs to be confident in that social context in order to be able to use intellectual tools. It is an important distinction as regards the rules and the tools.

...

"A Hierarchy of Knowing

"If one regards the dynamic properties of knowledge the most material, the notion Process-of-Knowing probably gives a better description than the word "knowledge". Bertil Rolf suggests in his book Profession, Tradition och Tyst Kunskap (1991) a hierarchy of knowing based on how the rules are followed: The lowest level of knowing is to follow rules which can be controlled by the subject itself, Skill The next level is to follow rules which are established by a social context outside the individual, Know-How The highest level is to be able to (and be allowed to) change the rules, competence or perhaps better in contemporary English expertise. Each level contains both tacit and focal knowing.

"Skill is the ability to act according to rules which depend on feedback from a non-social environment.

...

"Know-how includes skill and is the ability to act in social contexts.

...

"Expertise is know-how + the ability of reflection. Expertise or Competence in Polanyi's sense implies the ability of know-how within a certain domain and the ability not only to submit to the rules but also by reflection influence the rules of the domain or the tradition. Expertise is thus not a property but a relation between individual actors and a social system of rules. A person is an expert within a tradition: In a competent mental act the agent does not do as he pleases, but compels himself forcibly to act as he believes he must.

"Polanyi also makes an illustration of incompetence: We draw here a distinction between two kinds of error, namely scientific guesses which have turned out to be mistaken and unscientific guesses which are not only false but incompetent.

"An individual is thus not competent per se, rather it is the individual in a role and in a context who is competent or not. In order to change the rules a competent individual needs a social or interpersonal communicative knowledge in addition to know-how. It is the expertise of mastering the rules of the profession so well that they no longer need to be obeyed. A characteristic of expertise compared to know-how and skill is that the actor has power over his own knowledge, i.e. over the rule system which decides quality standards. Only when an individual has this kind of power is the system in the position to learn from the experience of the individual.

...

"Intellective and Agentive Knowing

"As I suggest in this Paper, work also has an Intellective and Agentive Knowing dimension. Agentive knowing is more oriented towards using the body as a tool whereas intellective process-of-knowing is oriented towards using the mind as a tool. Agentive skills are therefore more emotional and body oriented than intellective skills. Intellective abilities tend to be more analytical. Agentive skills are more oriented towards the synthetically. The distinction is made because these two dimensions are important in the Information processing professions and in organisations employing mainly professionals. It is not possible to be too distinct, however, since knowing includes always usage of both mind and body. The border between the two is thus fuzzy. One might see the categorisation as a family of abilities with biases towards one of the two categories.

“Tradition of Knowledge

“One of the central concepts in Polanyi’s concept of knowledge is tradition. Tradition describes how knowledge is transferred in a social context. The tradition is a system of values outside the individual.

...

“Polanyi is mainly interested in transfer of a process-of-knowing from one person to another(s) and he identifies three tacit psycho-social mechanisms for this: Imitation, identification and learning-by-doing. They are mechanisms for direct knowledge transfer. Facts, rules and exemplars are transferred without intermediate storage in a medium. The term I use - Knowledge "transfer" - is therefore not quite appropriate, since knowledge is not moved as goods. The "receiver" reconstructs his/her version of the "supplier’s" knowledge.

...

“Polanyi does not distinguish the implications of the difference between interactive knowledge transfer (as in a tradition) direct from individual to individual and indirect knowledge transfer via a medium like information. Organisations involved in production and selling of information rely on more indirect vehicles like mass media, manuals, books, or computer programs. Articulated rules (maxims) for guiding behaviour like texts in manuals or accounting procedures, check lists, handbooks, and guidelines for salesmen etc. are also examples of indirect knowledge transfer.”

Appendix E: "What is Volume?"

In this appendix we included reference information that show the enormous existing volume and ongoing growth in volume of available information world-wide. These tables are available online by searching on search engines such as Google for the key words "how much".

E.1 Information volumes in perspective

Many of the following facts were taken from Roy Williams "***Data Powers of Ten***" page at Caltech. See: http://www.ccsf.caltech.edu/~roy/dataquan/

Byte [8 bits]

- 0.1 byte: a binary decision;
- 1 byte: a single character;
- 10 bytes: a single word;
- 100 bytes: a telegram or a punched card;

Kilobyte [1,000 bytes or 10^3 bytes]

- 1 Kilobyte: A very short story;
- 2 Kilobytes: A typewritten page;
- 10 Kilobytes: An encyclopaedic page or a deck of punched cards;
- 10 Kilobytes: A static web page;
- 50 Kilobytes: A compressed document image page;
- 100 Kilobytes: A low-resolution photograph;
- 200 Kilobytes: A box of punched cards;
- 500 Kilobytes: A very heavy box of punched cards;

Megabyte [1,000,000 bytes or 10^6 bytes]

- 1 Megabyte: A small novel or a 3.5 inch floppy disk;
- 2 Megabytes: A high resolution photograph;
- 5 Megabytes: The complete works of Shakespeare or 30 seconds of TV-quality video;
- 10 Megabytes: A minute of high-fidelity sound or a digital chest X-ray;
- 20 Megabytes: A box of floppy disks;
- 50 Megabytes: A digital mammogram;
- 100 Megabytes: 1 meter of shelved books or a two-volume encyclopaedic book;
- 200 Megabytes: A reel of 9-track tape or an IBM 3480 cartridge tape;
- 500 Megabytes: A CD-ROM or the hard disk of a PC;

Gigabyte [1,000,000,000 bytes or 10^9 bytes]

- 1 Gigabyte: a pickup truck filled with paper or a symphony in high-fidelity sound or a movie at TV quality;
- 2 Gigabytes: 20 meters of shelved books or a stack of 9-track tapes;
- 5 Gigabytes: 8mm Exabyte tape;
- 20 Gigabytes: A good collection of the works of Beethoven or 5 Exabyte tapes or a VHS tape used for digital data;
- 50 Gigabytes: A floor of books or hundreds of 9-track tapes;
- 100 Gigabytes: A floor of academic journals or a large ID-1 digital tape;
- 200 Gigabytes: 50 Exabyte tapes;
- 500 Gigabytes: The biggest FTP site.

Terabyte [1,000,000,000,000 bytes or 10^{12} bytes]

- 1 Terabyte: An automated tape robot or all the X-ray films in a large technological hospital or 50000 trees made into paper and printed or daily rate of EOS data (1998);
- 2 Terabytes: An academic research library or a cabinet full of Exabyte tapes;
- 10 Terabytes: The printed collection of the US Library of Congress;
- 50 Terabytes: The contents of a large Mass Storage System;
- 400 Terabytes: National Climactic Data Center (NOAA) database;

Petabyte [1,000,000,000,000,000 bytes or 10^{15} bytes]

- 1 Petabyte: 3 years of EOS data (2001);
- 2 Petabytes: All US academic research libraries;
- 8 Petabytes: All information available on the Web;
- 20 Petabytes: Production of hard-disk drives in 1995;
- 200 Petabytes: All printed material or production of digital magnetic tape in 1995;

Exabyte [1,000,000,000,000,000,000 bytes or 10^{18} bytes]

- 2 Exabytes: Total volume of information generated worldwide annually.
- 5 Exabytes: All words ever spoken by human beings.

Zettabyte [1,000,000,000,000,000,000,000 bytes or 10^{21} bytes]

Yottabyte [1,000,000,000,000,000,000,000,000 bytes or 10^{24} bytes]

E.2 Existing World-wide Information Volumes

University of California Berkeley's School of Information Management and Systems explicitly addresses the growing need to manage information more effectively. They are studying the world-wide growth in information growth and publishes a report on a regular basis; treating the report as a "live report". Their method is explained in the executive summary as follows:

> "***In 2000 we conducted a study to estimate how much information is produced every year (see http://www.sims.berkeley.edu/research/projects/how-much-info/). We then estimated that in 1999 the world produced between 1 and 2 exabytes of unique information. In Summer 2003 we repeated the study, using 2002 data, in order to begin to identify trends in the production and consumption of information. Some of the 1999 data has been revised in this study because new information sources were identified; our revised estimate is that in 1999 the world produced between 2 and 3 exabytes of new information."***

Summary of Findings from the 2003 executive summary: How much information – 2003

"How much new information is created each year? Newly created information is stored in four physical media – print, film, magnetic and optical – and seen or heard in four information flows through electronic channels – telephone, radio and TV, and the Internet. This study of information storage and flows analyzes the year 2002 in order to estimate the annual size of the stock of new information recorded in storage media, and heard or seen each year in information flows. Where reliable data was available we have compared the 2002 findings to those of our 2000 study (which used 1999 data) in order to describe a few trends in the growth rate of information.

"Print, film, magnetic, and optical storage media produced about 5 exabytes of new information in 2002. Ninety-two percent of the new information was stored on magnetic media, mostly in hard disks.

"How big is five exabytes? If digitized with full formatting, the seventeen million books in the Library of Congress contain about 136 terabytes of information; five exabytes of information is equivalent in size to the information contained in 37,000 new libraries the size of the Library of Congress book collections.

"Hard disks store most new information. Ninety-two percent of new information is stored on magnetic media, primarily hard disks. Film represents 7% of the total, paper 0.01%, and optical media 0.002%.

"The United States produces about 40% of the world's new stored information, including 33% of the world's new printed information, 30% of the world's new film titles, 40% of the world's information stored on optical media, and about 50% of the information stored on magnetic media.
How much new information per person? According to the Population Reference Bureau, the world population is 6.3 billion, thus almost 800 MB of recorded information is produced per person each

year. It would take about 30 feet of books to store the equivalent of 800 MB of information on paper. We estimate that the amount of new information stored on paper, film, magnetic, and optical media has about doubled in the last three years.

"***Information explosion?*** We estimate that new stored information grew about 30% a year between 1999 and 2002.
"***Paperless society?*** The amount of information printed on paper is still increasing, but the vast majority of original information on paper is produced by individuals in office documents and postal mail, not in formally published titles such as books, newspapers and journals.

"Information flows through electronic channels -- telephone, radio, TV, and the Internet -- contained almost 18 exabytes of new information in 2002, three and a half times more than is recorded in storage media. Ninety eight percent of this total is the information sent and received in telephone calls - including both voice and data on both fixed lines and wireless.

"Telephone calls worldwide – on both landlines and mobile phones – contained 17.3 exabytes of new information if stored in digital form; this represents 98% of the total of all information transmitted in electronic information flows, most of it person to person.
Most radio and TV broadcast content is not new information. About 70 million hours (3,500 terabytes) of the 320 million hours of radio broadcasting is original programming. TV worldwide produces about 31 million hours of original programming (70,000 terabytes) out of 123 million total hours of broadcasting.

"The World Wide Web contains about 170 terabytes of information on its surface; in volume this is seventeen times the size of the Library of Congress print collections.
Instant messaging generates five billion messages a day (750GB), or 274 Terabytes a year.
Email generates about 400,000 terabytes of new information each year worldwide.
P2P file exchange on the Internet is growing rapidly. Seven percent of users provide files for sharing, while 93% of P2P users only download files. The largest files exchanged are video files larger than 100 MB, but the most frequently exchanged files contain music (MP3 files).

"How we use information. Published studies on media use say that the average American adult uses the telephone 16.17 hours a month, listens to radio 90 hours a month, and watches TV 131 hours a month. About 53% of the U.S. population uses the Internet, averaging 25 hours and 25 minutes a month at home, and 74 hours and 26 minutes a month at work – about 13% of the time."

End of Appendices