Discussing the supporting role of Information Technology for human and organizational knowledge sharing with a special focus on consultancies

Peter Dikow
Discussing the supporting role of Information Technology for human and organizational knowledge sharing.

With a special focus on consultancies

Author:
Peter Dikow
14.06.2005
Content:

Introduction......................................................................................................................5
1.1 Problem discussion............................................................................................5
1.2 Purpose .............................................................................................................8
1.3 Discussion of research methods........................................................................8
  1.3.1 Mathematical approaches ...........................................................................9
  1.3.2 Conceptual- analytical approaches ...........................................................10
  1.3.3 Theory-testing approaches .......................................................................10
  1.3.4 Theory-creating approaches .....................................................................11
  1.3.5 Constructive research ...............................................................................11
1.4 Applicable method for the problem ..................................................................12
1.5 Data gathering and reliability issues ................................................................13
2 Background on the subject area .............................................................................13
  2.1 Cognition: biological and psychological foundations ........................................14
    2.1.1 Perception .............................................................................................15
    2.1.2 Memory and Learning ...........................................................................16
      2.1.2.1 Memory .............................................................................................16
      2.1.2.2 Learning ............................................................................................18
      2.1.2.3 E-Learning or one-person-knowledge ...............................................20
  2.2 On data, information, content, knowledge and wisdom ...................................23
  2.3 Information Technology ...................................................................................28
  2.4 Knowledge Management in general ..............................................................30
  2.5 The consulting business ..................................................................................34
    2.5.1 Consultants .............................................................................................36
    2.5.2 Knowledge Management for consultancies ..............................................37
    2.5.3 Knowledge development .........................................................................38
3 The knowledge process ..........................................................................................39
  3.1 Human Knowledge Process ............................................................................39
  3.2 Knowledge in groups .......................................................................................41
  3.3 Organizational knowledge process ..................................................................43
    3.3.1 Organizations ...........................................................................................43
    3.3.2 Knowledge from an economic point of view ..............................................55
    3.3.3 Special knowledge in consulting companies .............................................58
  3.4 Knowledge sharing among humans in an organizational setting .....................60
    3.4.1 Sharing barriers ......................................................................................66
    3.4.2 Narratives .................................................................................................74
  3.5 Need for Knowledge Management .....................................................................76
  3.6 Knowledge Management Systems - KMS .......................................................77
4 Conclusion..............................................................................................................88
5 References .............................................................................................................89
Table of figures:

Figure I Järvinens taxonomy of research approaches ..................................................... 9
Figure II The knowledge pyramid by Aamondt and Nygard ................................................. 24
Figure III The four knowledge creation modes by Nonaka....................................... 49
Figure IV Vicious circle of knowledge quality ................................................................. 83
Figure V Reinforcement of knowledge management efforts ........................................... 85
Introduction

The history of technology has shown that with the advance of science almost any manual human task could also be done by a machine. This story of success gives hope for the subject area of artificial intelligence and Cognitive simulation. It is easily comprehensible that the automation of manual tasks is very successful, since it is of very obvious nature. Exactly this factor is the biggest problem in understanding cognitive processes and other products of our mind, that they are not obvious at all. AI scientists assume that the human brain conducts tasks comparable to a digital computer and must therefore be reproducible as a computer. This view is supported by psychologists who use basic information processing models adapted from computer science to explain the human thought process (Lindsay et. al., 1977). Unfortunately, psychologists are still not completely sure of the way our mind works. We are well aware of the outcome and can predict some of them, but the working procedure behind our decisions remain a mystery. Hubert Dreyfus (Dreyfus, 1999) critically reviewed the psychological, epistemological and ontological grounded expectations of Artificial Intelligence workers. It is his conclusion that the enduring failure of AI to technologically reproduce the function of the human brain serves as empirical evidence against the Foundations of AI itself. According to the Author, it has also not been scientifically proven by the AI community that “the mind must obey a heuristic program”. In fact, psychology suggests that humans commonly make decisions without even considering the situation or their set of standards (Smith, 2003). Dreyfus proves that “arguments which are supposed to show that formalization must be possible are either incoherent or self-contradictory”. Therefore it seems to me, that the current state of the art in AI and Cognitive simulation is at the very limits of technology. For this reason it seems relevant to explore to what extend the current findings and technological solutions can be used to support the activity of the human brain, since it is not possible to replace the human brain by a computational device.

1.1 Problem discussion

Introduction to the problem area

At the present time, most companies and managers are aware of the importance of knowledge management and knowledge being the most important asset of most companies today (Grant, 1996; Gronau, 2001). There are a number of different disciplines involved with this central responsibility. For the most, the studies of psychology and economics are concerned with this area. But since the 1980’s it were mostly computer science and information technology, which promoted knowledge facilitating computer programs and therefore knowledge management in the global economy (Klosa, 2001; Lehner, 2000). It is because of the enormous size, diversification and distribution of today’s companies and other networks that sharing and communicating knowledge must be computer supported. This applies the most to consulting companies, because their employees are mostly doing their job at the clients’ site of business and in addition operate in very time critical and diversified business
areas (Haun, 2002). And not seldom they are working around the world in different time zones and cultures, what condemns the common, local approaches which rely on personal interactions and meeting points. Therefore a computer-network based approach is inevitable.

Due to the rapid progress in information technology, a lot of the implemented solutions lack a scientific foundation, which in most cases lead to a series of problems (Bach, 1999), this thesis intends to deal with. Ongoing research in this field lead to a number of concepts for knowledge management which try to cope with these problems and are now widely applied in almost all economic enterprises. Here they became an important factor in competition.

But there is a completely different situation in the consulting sector. Here, the enterprises have to deal with special conditions that exist only in this business area. From a knowledge point of view, consultancies have to deal with extreme circumstances compared to other businesses (Haun, 2002). It is very difficult to handle the flow of information or the communication in consulting firms due to the mobility of the employees and the spatial fragmentation of knowledge involved. Even more so as there is a relatively high fluctuation of employees compared with other lines of business, which increases the probability of loss of knowledge for the enterprise.

Another problem is that the employee of a consulting firm defines himself by his knowledge and needs to hold his expertise on his own in order to be indispensable for the enterprise.

Finally, consultancies differ in an other aspect concerning the use of knowledge from other producing firms. Consulting business is not about applying rules and methods to problems, but about being creative and using experience. Here, knowledge is not just data of some kind but already meta-data that describes how a solution to a problem can be created. But to my knowledge it has not jet been achieved to extract these methods in a general sense. Conventional KM systems focus on storage of data but as shown above, this is not sufficient in this case.

All of this makes knowledge management an important but complex issue in this line of business.

Haun (Haun, 2002) describes the daily work of a consulting firm as mainly consisting of activities in different projects for different customers. In principle, these projects are unique because at least the starting state and the requirements set by the customer differ from project to project. Nevertheless, all these projects have a lot of commonalities. This could be the same problem definition or that the general conditions and requirements are repeatedly given. Despite of a lot of differences between single projects, in every project, there are solutions and concepts being developed that can be used as references and patterns or just give ideas for the work with another project. These solutions constitute acquired knowledge. The reuse of this knowledge in further projects can result in savings of time and therefore in the reduction of cost. But it is rather difficult to extract the desired information in a non-catalogued assortment of artifacts of any kind from different projects. Even a consultant who participated in an earlier project and is familiar with the corresponding documents is hardly able to find the documents in question. Exactly this circumstance and the fact that consulting firms in general are subject to a high fluctuation of employees make the storage of knowledge in the enterprise even more difficult. To make matters worse, Haun states that the
individual employee is not always available but involved with work at the customers’ place of business for a long period of time. For this reason, it is rather difficult for other employees to access the project knowledge of other consultants.

Bach (Bach, 2000) describes the “necessity for an integrated and holistic approach” to the knowledge management in the consulting business because of the “various knowledge from different areas that comes together in consulting companies.” This is why such a solution can also not stand alone but must be integrated in the business process. This can be rather difficult, taking into account, that there is a unique situation in every single company.

These well known issues stated above are just the tip of the iceberg in the problematic around knowledge in an organizational setting. They represent only the obstacles which come with the distributed organization. An organization also constitutes a social construct which can have a great impact on the members’ willingness to share knowledge and also on the possibilities to create knowledge. Anyhow, Knowledge is by definition (which will be coming up) an exclusively human feature. For this reason, I will first discuss the knowledge process from a human point of view, which will be broadened to the view of knowledge on a group level and finally in the organizational environment. This is necessary to show the dependency of the organizational knowledge process on the individual action. This is further explained when I consider the knowledge sharing process in Organizations which is the core activity in this subject area.

Having stated that knowledge is a human property, it is necessary to say that the reader must be constantly aware of this definition and should not be confused, when terms like “organizational knowledge” come up. They will be explained separately and should not be taken literally. Anyway, they are widely used in literature due to lack of alternatives. It is also quite common to use the terms information and knowledge synonymously. Although I will clearly distinguish these terms, I adopt this practice to be consistent with literature. The reader must determine the meaning of the terms by considering the context.

On a side note I would like to give a brief history of my thesis work which I think is very helpful in understanding my interest in this subject matter. Before my studies at Växjö Universitet I just finished a six month apprenticeship at a consulting company in Munich. During my work at the company I became aware of some apparent flaws in the knowledge management and document handling. This was when I decided to write my master thesis in cooperation with this company. At this time I intended to create a general model for IT based knowledge management for consultancies. I even started out with a questionnaire trying to explore the requirements the consultants had in mind for a holistic support system. But while I was doing research on other knowledge management approaches I realized that there were quite a few solutions and concepts available. From that point on trying to find a special solution for this company felt more and more like fighting symptoms of a disease. At the same time I also found out, that whatever practical solution I investigated, there was always some problem so that the desired effect could not be achieved. I had to conclude that all these companies must have misunderstood something along the way during the creation of
their solution. This way I became very interested in how the knowledge process works and which tools provided by information technology are really applicable.

1.2 Purpose

The purpose of this paper is to discuss the process of knowledge creation on every level of an organization. This shall include the creation of knowledge by a single individual, the creation and sharing of knowledge among a small group and also on the level of the whole organization. During the whole discussion the focus will lie on the possible use of technology to support the specified process. Each process will be broken down to crucial parts to be able to identify the possible entry points for technological aid. By doing so, it can be ensured, that requirements for a supporting system can be kept to a minimum. In addition, this makes it also possible to fully exploit the technological capabilities we have at hand. It is my goal to clarify the current role of information technology in supporting the human process of knowledge creation in an organizational setting. In order to construct a holistic review of the subject area, I will always keep the connection to knowledge as a human property rather then focusing solely on the tremendous capabilities modern information technology has to offer.

1.3 Discussion of research methods

To ensure the scientific quality of the thesis work, the author should follow some structured and approved research method. This way, the chance of mistakes can be reduced to a minimum. It also increases the understandability of the thesis, if the reader recognizes a pattern and finds it therefore easier to follow the conclusions the author draws.

Järvinen (Järvinen, 1999) describes various research approaches for theoretical and empirical studies also taking into account other models of research approaches. Järvinen's tree-like taxonomy presents the most complete picture of the available research methods. It considers mathematical, theoretical and empirical research issues. The scientist must decide whether the research deals with formal mathematical problems, the utility of artefacts or simply with reality. Subsequently, more detailed approaches are deduced from these wider areas so that most scientific researches are captured. The following figure shows Järvinen's classification of research methods. In the following subchapters I would like to discuss the different methods and their applicability to the problem my thesis is concerned with. Finally, I shall narrow my choice up to one method that suits the problem best.
1.3.1 Mathematical approaches

Mathematical research starts with assumptions and presuppositions about reality. But “mathematical notations do not have any direct connection with reality” (Järvinen, 1999). Mathematical notations are unambiguous and therefore there is no possibility for different interpretations. This way, other scientists can easily verify the way and results of any mathematical research. The greatest source for discussions with this type of research, is “how well does the models correspond to reality?” Hence, the point of critique is not the research itself but the assumptions made at the beginning and the interpretation of the results.

According to Järvinen (Järvinen, 1999) mathematical research is concerned with formal languages, algebraic units or the proof of theorems. Since the problem stated in the chapter on the purpose of this thesis is clearly situated in reality and concerned with the practical application of information technology, I can definitely say that this research method will not be of use for this thesis. Anyway, I expect some consideration of algorithms and other tools information technology provides, but I certainly will not stress the mathematical internals of these constructs. Therefore, I will not use a mathematical approach for my thesis research.
1.3.2 Conceptual- analytical approaches

Conceptual- analytical research is concerned with theoretical studies that can be based on empirical research. According to Järvinen (Järvinen, 1999) This kind of research approach tries to answer the question: “What is a part of reality according to a certain theory, model or framework?” The reflection of reality in a theory involves several steps. At first, all entities which interact in reality, must be captured with their behaviour and states in concepts. There are four types of concepts available:

- Individual concepts, describing properties of a single individual
- Class concepts, describing classifications of entities and objects
- Relation concepts, describing relations (e.g. “belong”, “between”, etc.) between objects
- Quantitative concepts, functions describing relations of variables

Järvinen (Järvinen, 1999) further states that “the theory collects, integrates and systematizes separate previous research results”. This includes the formerly described concepts which, put together to a theory, describe a reality.

One of the goals of this thesis is to get a holistic view on knowledge creation in organizations and how information technology can be matched on this concept. This includes the comparison of practical information technology application with the requirements of the knowledge creation theory, which will be developed simultaneously. This corresponds to the description from above describing conceptual- analytical approaches as a reflection of reality in theory. Additionally, I expect a huge amount of literature studies to lie ahead since a holistic understanding of the knowledge process most likely involves several subject areas which I am not familiar with at this time. Therefore previous research results in this subject matter will be a broad basis for this thesis. This is jet another feature of the conceptual- analytical research approach which makes it suitable for this research work.

1.3.3 Theory-testing approaches

This kind of research approach tries to answer this question: “Does a part of reality correspond to a certain theory, model or framework?” (Järvinen, 1999)). The method tries to stress the correctness of a theory, by falsifying or confirming it with experiments and field or case studies. Markus (1983) defines three ways to test a theory:

- Testing of predictions derived from theories by comparing them to observed occurrences
- Comparison of real-world facts with basic assumptions which underlie the theory
- Testing the usefulness to implementers of implications for action derived from the theory

A prerequisite for the interesting appliance of this method is, that the theory can be falsified. Otherwise, the stressing of the theory lacks importance and is scientifically not
important. Well known theory-testing approaches are: controlled experiment, various field methods, case-research, text analysis, verbal protocol analysis and script analysis.

This thesis shall be concerned with the building or better, the understanding, of a theory and its emergence in reality. Although I would like to stress the proper application of information technology, I do not intend to stress the theory of knowledge creation itself. Therefore, it does not seem appropriate at this point to consider a theory-testing approach for my research work.

1.3.4 Theory-creating approaches

Theory-creating approaches are used if there is no prior knowledge of a part of reality or a phenomenon. Scientists try to describe and explain their observations they make in case studies, content analyses, ethnographic and other studies. Hereby, not only contemporary realities, but also past realities can be considered. Järvinen (Järvinen, 1999) presents five different methods which can be used as a theory-creating approach:

- **Grounded theory**, “is discovered, developed and provisionally verified through systematic data collection and analysis of data pertaining to the phenomenon under study.”
- **Case study**, where theories are developed from well selected case scenarios
- **Phenomenography**, qualitative method, stressing the perception of reality
- **Contextualism**, observing objects within their context
- **Ethnography**, long-term participation of the researcher in the area under study

Although this approach reflects the general idea of this thesis, I does not seem suitable for me because I see the theory I try to understand with this thesis on a much larger scale as this approach does. By now I think that the process of knowledge creation involves elements from several areas like psychology or social science. Regarding this process in an organizational context gives the problem jet another dimension which makes it hard to think of a single simple theory which supposedly describes a single bounded phenomenon. I find it hard to consider the proposed research methods for my thesis because they focus on the work on a narrow subject, which unfortunately is not given in the case of my thesis.

1.3.5 Constructive research

Constructive research is the most practical oriented research method presented in this paper. This approach is concerned with the quality of any kind of artefact or with the way, a certain artefact could be built.

To build an artefact, Järvinen (Järvinen, 1999) distinguishes between basic and applied research. “The purpose of the basic research is to find out what is a part of reality.” Continuing, applied research uses the results of basic research to reach a final state with an object under study. Most common, constructive research is used to build a new artefact or at least a prototype.
During the investigation of the usefulness of an artefact, scientists develop metrics. Subsequently, the performance of the object under study is measured against these metrics.
At this point I will discontinue to explain this method into detail, since my thesis-problem does not contain an artefact that needs to be stressed. This method is therefore also not an option for my thesis work.

1.4 Applicable method for the problem

During the discussion of the different research methods above, I considered the conceptual – analytical approach to be the best alternative to support my scientific thesis work. This approach is about creating a new theory about a subject area. I will now describe this approach in more detail, so that it can be determined if it is really suitable for this problem solution.

According to Järvinen (Järvinen, 1999) a theory does not only contain true clauses but also some propositions. The outcome of a theory creating approach also depends on weather the theory is descriptive or normative and additionally also on the creation process which can be of an inductive or deductive nature.
If a theory is based on empirical observations or generalizations, the process is called inductive. This includes the addition or deletion of concepts and relations to or from the theory. The deductive approach summarizes the derivation of theories from axioms or assumptions, including the combinations of two theories to one new theory and the adoption of a theory from an other discipline.
I can already assume that I will be using an inductive approach to find the theory that describes the problem area, since the main thesis work will be the studying of literature containing existing theories on the subject from different sciences. I intend to not only collect theories but also empirical studies which hopefully help to clarify the overall relations between the different theories. By modifying, adjusting and merging all these outcomes, it should be possible to build a holistic theory of knowledge creation in an organizational context.

Of course I am aware, that I certainly will not produce a scientific theory in the sense Järvinen (Järvinen, 1999) describes it. Since I am heading for a broad view on knowledge creation regardless of the scientific field the different steps take place, it is probably impossible to give clear definitions like a scientific theory would demand. But at least for this thesis, there is no need for such a detailed and consistent approach since this is only one part of the work ahead. The second part and most important part will be the derivation of possible integration points for information technology from the theory. By matching up the theoretical evolution of knowledge and the way information technology does or could support it, it should be possible to identify the biggest challenges computer scientists face in this matter.
1.5 Data gathering and reliability issues

To ensure the quality of one's research, it is not only important to follow a verified research method. It is equally important that the data one gathers to be interpreted is reliable.

Järvinen (Järvinen, 1999) lists a number of data gathering techniques: interviews, observations, literature study etc. At this point I assume that I will focus primarily on literature studies. Since in the last years, scientific online libraries emerged in large numbers and are easily accessible for university students I have not only access to large official publications like books, but also to a vast number of white papers and smaller scientific reports which are not published as books. This offer covers probably all available sources for reliable scientific material.

Järvinen (Järvinen, 1999) cites Bell (Bell, 1993) considering two major ways to analyze documents. These are external and internal criticism. External criticism is concerned with the authenticity and reliability of the document. Having in mind that I plan to acquire these documents from official university libraries, I can be assumed that all these documents pass external criticism. Internal criticism on the other hand deals with the scientific content of the document of question and therefore will be the most important part of my work.

Continuing, Järvinen distinguishes between primary and secondary literature sources meaning actual original documents that came into existence during the period under research and literature which discusses primary sources. Because of the diversity of the subject area I plan to discover, I expect a lot of work with both types of documents, not at last because the subject is not only very diverse but also disputed.

2 Background on the subject area

For the attempt to identify possible support for knowledge creation it is a prerequisite to be aware of the basic and advanced concepts of knowledge and the knowledge creation process. Since this thesis is also concerned with knowledge in an organizational setting and on a special focus also with the knowledge in consulting companies, I will also discuss the underlying concepts of these systems. These understandings are necessary because this paper also tries to align the concepts of information technology with the needs of the processes it is supposed to support. This chapter will cover the psychological foundations of human knowledge as well as a basic description of the importance of knowledge for the corporate world, specifically consultancies, and basic principles of knowledge management.
2.1 Cognition: biological and psychological foundations

Lindsay et. al. (Lindsay, 1977) define the cognitive science as the subject area of information processing. From a human perspective, this incorporates all the intellectual processes through which we obtain information from the world, change it to meet our needs, store it for later use, and use it to solve problems. Lahey (Lahey, 1998) finds the interpretive processes of perception and thinking to be at the center of cognition. They perform the most critical task in this process, the transformation of incoming information. The term thinking is hereby used to describe the processes of recognizing objects or occurrences and operations that involve the use of our memory. The obtaining and later storage and retrieval of information is rather mechanical but can not be neglected, since they are all part of a chain of tasks which lead to knowledge creation. And it is commonly known that a chain is only as strong as its weakest link. Therefore I will investigate the processes of perception, thinking or learning, and memory for possibilities of improvement through technological means.

As stated in the introduction, the human mental processes have a lot of similarities with modern computer programs. In fact, Psychologists use a basic computing model, involving a CPU, memory and input – output streams to introduce subject novices to mental processes (Lindsay, 1977). Researchers in psychology hoped to be able to project the findings of AI concerning processing of complex information to the human mind to get a deeper understanding. Although computer science inspired theories about how information can be stored and broken down into a binary code for processing, it was not possible to transfer the binary processing method to a psychological theory (Best, 1986). Until today, human thinking could not been explained or reproduced by a set of complex rules. It still seems too flexible to be compared literally to a technological computing mechanism.

In order to investigate the creation of human knowledge it is necessary to begin with the absolute beginning of this production. On the one hand, this brings a complete understanding of the subject matter. And on the other hand, commencing step by step from scratch to the creation of knowledge it is possible to identify the earliest stage during this process, where technology of any kind could be applied to facilitate and enrich the production of knowledge. As described above human knowledge is based on data and information. Understanding the storage and retrieval of information in the human brain is a matter of psychology. Although there are different branches of psychology, there is a general understanding that there are three stages which lead to the storage of information in human memory. Humans perceive a certain stimulus, attend to the stimulus and recognize it. This cognitive process is followed either by the discarding of the information, also known as forgetting, or the storing of the information in the brain for further reuse (Lahey, 1998). Lindsay et. al. (Lindsay, 1977) give an example for the widely acknowledged storing process in the human brain. Three types of storage are used, which can be differentiated by both, their storage capacity and length of storage capability. At first, there is the sensory storage storing sensory inputs for parts of a second to enable the human to attend to the input even if the sensory impulse is long gone. This storage is rather large so that complete images can be stored in detail. Perceived inputs are forwarded to the second storage, the short term memory. Here,
information can be held up to 20 seconds and conscious tasks can be performed upon it. Short term memory can be accessed very quickly and contains only that information one attends to. In average, this is around seven “memory items”. Processing information which is held in the short term memory leads to the storage in long term memory. Through rehearsal and attention information we are interested in is being stored in long term memory. From this large deposit we can retrieve stored data if necessary.

2.1.1 Perception

Lindsay et. al. (Lindsay, 1977) describe perception as "the active psychological process in which stimuli are selected and organized into meaningful patterns".

Humans use their sense organs as an interface to the environment. These organs are exclusively used to process external signals which arrive in different physical ways at the body and are absorbed. A sensory input is at first stored in the sensory storage which is of enormous capacity to hold all the perceived information. Since one has not jet decided which part of the input is important or needed for further processing, all available information is stored here. The Sensory Storage looses the stimulus input after 10th of second up to a second if the human does not attend to it which basically means the perceptive process.

Perception describes the internal process of attributing a meaning to these physical occurrences. Only then, this external input constitutes an experience for us. A prerequisite for processing is of course that we attend to the stimulus to be processed. Lindsay et. al. (Lindsay, 1977) define attention as “the process of selecting from the vast amount of incoming information that is processed and eventually perceived consciously”. It is also the first step of identifying a new occurrence by collecting the various features of the stimulus. This status is comparable to the idea of symbols, which do not have any meaning without a syntactic structure attached to them. Until now, the incoming event does not have any meaning to us at all. This is why the next step of recognition is to find the corresponding structure for the perceived symbols. The common approach for the solution of this problem is to compare the occurrence to known templates. This method is also known as pattern recognition. Best (Best, 1986) assumes that all complex stimuli are composed of distinctive and separable parts which he calls features. The presence or absence of features of a new input is counted and this count is compared with a table of features of different templates. This is also the method which is used by modern technology to solve this problem. If a corresponding pattern is found, the according meaning can be attached to the input. Unfortunately, this solution has one flaw. The probably unlimited number of differences that makes it possible to distinguish between all possible items and happenings makes it inevitable to compare the incoming event to exactly all these possible patterns to find the matching one. Therefore a huge amount of templates must be held available for fast recognition. To avoid the handling of large data, human perception uses a different technique. Lindsay et. al. (Lindsay, 1977) describe the human perceptual system a conceptually driven, as opposed to the data-driven approach of the technical solution. Instead of matching up one single piece of information with a huge database (data-driven) the conceptual idea is to process a large junk of information, making deductions and filling in the gaps. Humans use
conceptualization of the event to find possible interpretations before comparing it with known patterns. By this means, the recognition process is speeded up, because the gained expectation what the event might be, leads to quicker finding of a corresponding template. The Authors also accredit the human perceptual system to use context to facilitate the process. Contextual information to the fact that is being processed also enhances the speed of recognition. Based on the context attached to a piece of information, we use our general knowledge to tailor the concept-driven process. In addition to these cognitive frameworks to identify incoming information, humans in social context also use stereotypes in this process. Information perceived in a specific social context is automatically compared to a specific frame of reference concerned with that very context.

The context- and concept-driven recognition method of the human mind has no problems to immediately discard useless information and to focus on the promising parts, which lead to the finding of a familiar pattern. Although modern computers might easily cope with the data-driven technique of comparing inputs to known patterns, it was not possible by now to enable an electronic system to use this contextual approach to recognize objects or happenings. This superior and very flexible method used by the human is still not completely understood by psychologists and seems to occur on an almost molecular level.

In any case, the recognized sensory input is, as mentioned earlier, is diminished to its necessary parts, which still contain a lot more details that could be remembered later on, and is forwarded to the short term memory for further processing. These steps will be discussed in the following chapters. Anyhow, from now on, the input has been assigned a meaning and therefore constitutes information.

At this point I can only conclude that the human perceptive process can not be facilitated by technologies, because although the process itself can be described we fail in recreating it on any technological level. Even the enhancement of the sensory input will not lead to a better perception and therefore to a better knowledge process, since the perceptive process already has more information available than necessary. Additionally, we are not able to tell, which information is being used to recognize an event or object mentally. If so, we would have been able to artificially provide more useable information by performing a selective process prior to the sensation perceived by the human organs.

2.1.2 Memory and Learning

2.1.2.1 Memory

Much like modern computer systems, the human memory involves three central processes. It is commonly (Bennett, 1982; Smith, 2003) agreed on the stages of encoding, storage and retrieval. Smith defines the encoding stage as the activity of translating recognized environmental information into a meaningful entity and storing this entity in memory. The storage stage is seen as maintaining the stored information over time. Finally, retrieval of information means the access of information that hast been encoded and stored into memory before. All these three stages are crucial for our whole knowledge process. The phenomenon of forgetting is closely related to the three
memory stages. Any improper execution of one stage can result in failure to recall information. This can be because it has not been stored, has been lost in memory or was not properly linked, so that recall is impossible.

To be able to determine if technology can be of any use for these processes, it is necessary to extract the crucial activities for further consideration. As already known from the discussion about perception, humans maintain three different kinds of memory: Sensory Store, Short Term Memory (also known as Working Memory), and Long Term Memory. Since we are not actually consciously aware of the information placed in Sensory Store, it is only of interest, how the transfer of information from Short Term Memory to Long Term Memory is managed. But since the information stored in Short Term Memory is being transferred to Long Term memory, it is already very important to ensure the quality and consistency of this information. Here the three stages of memory can already be applied. Recognized information must be encoded into memory. Short Term Memory can handle phonological, visual or semantic codes. The perceived information is represented by either a mental picture, a sound that is remembered or a meaningful association. Especially with larger items to remember, our mind has the capability to optimize the storage of those items of information by chunking them together to pieces which are already present in Long Term Memory, so that the don’t have to be stored again.

Short Term Memory is only capable to hold Information for about 20 seconds. To prevent the decay of stored information, psychologists have determined that “maintenance rehearsal” prolongs the storage of the information for another 20 seconds after a rehearsal. If we discontinue this kind of rehearsal, we lose the information after the period of 20 seconds. Unfortunately, Smith assigns Short Term Memory only a capacity of seven items of information. Due to this limited capacity and the short period of time, Short Term Memory is not suited to store Information for longer time. For this reason we shall investigate the transfer of Information to Long Term Memory, which is a large repository of information we maintain of all information that is generally available to us. The capacity of the Long Term Memory is according to today’s belief in psychology unlimited. The transfer process from Working Memory to Long Term Memory is known as elaborative rehearsal. This can basically been understood as attending to this piece of information and intensive elaboration on it. During this process, we attach some meaning to the information and most of the time it is also stored as the meaning of the information, rather than the information itself (Smith, 2003). Hereby we get the better memory of a piece of information, the longer we elaborate on it and the more meaningful connections we attach to it. According to Smith, psychologists also hold two other factors in storing responsible for better memory. It is believed that carefully organized information is later better accessible. For retrieval it is an advantage to be in the same context in which the storage of the information has taken place.

This biological connection of a new piece of information with existing context and experiences from our current memory is considered as creation of knowledge. This production and the definition of knowledge will be clarified in the next chapter from a non-psychological perspective. At this state and from this biological point of view it is already possible to identify means that can be taken to facilitate the knowledge creating process.

As described earlier, Short Term Memory maintains representations of information as phonological and visual codes. In an office environment, we usually study material by reading. This constitutes only a poor visual and worse, no phonological representation of
the information. Therefore it is solely up to our mind to create corresponding sounds and images to support the storage of new material. Encoding can be enhanced by using images or extensive elaboration or organization into a pattern. This brings information into a context and constructs a number of links to other memories by which it can be reconstructed upon retrieval. At this stage of knowledge creation, an audio-visual supported presentation of material to learn is a task that can easily be performed by information technology. Here, multimedia presentations come to mind.

Going on in the knowledge process, the storing of the information is performed by applying meaning and connections to related information. Also here, it is only logical to provide already linked information to the human “reader”. This way it can be achieved that the human mind makes a maximum of possible connections while storing the new information in Long Term Memory.

This stage of the memory process can therefore be supported by prepared contextually linked multimedia presentations. Aware of the huge effort that is necessary to produce material that provides these features, it is inevitable to perform studies to show if this effort is in any sensible relation with the use, which at this point, is a first thought that must also be proven in its effectiveness.

A last process involved with memory after the encoding is of course the retrieval of the stored information. Basically, the retrieval process tries to find the desired information in the Long term memory storage by following the links we created during the encoding phase to other information in memory. The only critical factor here is the possibility of forgetting. Psychologists discovered two main theories why and how we forget which are of interest for the kind of information we are dealing with here. Lahey (Lahey, 1998) understands them as the decay theory and the interference theory. The decay theory proposes that memories which are not used fade over time. Psychologists have however discovered that this is only partly the case in Long Term Memory failure. This is where the interference theory comes in. Here it is believed that if similar memories are present in your memory storage, they interfere with retrieval of the desired information. In any case, both theories agree, that retrieval is done by reconstruction of the links to other memories that are more accessible to us. Lahey states that despite all possible memory interferences, the only factor for successful memory retrieval is the depth in which the information was processed or elaborated on.

Based on this statement, it seems sufficient to focus on the enhancement of the encoding process during information processing, since the later retrieval is only dependant on how well the information was encoded into memory. In the above I have already presented possible ideas for the support of this encoding stage through the use of information technology.

### 2.1.2.2 Learning

The earlier discussed processes of perception and memory are concerned with thinking, which involves the comparison of incoming information with available existing concepts. Different from this, learning is concerned with the formation of new, mostly more complex concepts (Lahey, 1998).
Maier et. al. (Maier, 2001) describe the three, most famous learning theories, which all derive from behavioral psychology. Namely, they are classical conditioning as known from Pavlov's famous experiments, instrumental conditioning, and social learning. They all are based on behavior and do not involve conscious learning.

Cognitive psychology presents an information processing approach to learning which explains the process of complex conscious learning, which this paper is concerned with. Cognitive psychologists agree on the following definition of learning: “a relatively permanent change in behavior that occurs as the result of experience and cannot be attributed to temporary body states…” (Hergenhahn, 2001; Smith, 2003).

As children we have to learn all the concepts we as adults take for granted. This kind of learning is easily achieved and supported by the environment and also the school system. Broad research has been conducted in this field and for this paper it is sufficient to accept that adults in our civilized world have a merely common basis of basic concepts. Therefore I will focus here on leaning concepts that cope with the way adults learn beyond commonly known concepts.

Mezirow (Mezirow, 1997) defines learning in his theory of adult learning. According to his theory, adults learn in four fundamental ways:

- expansion of existing meanings
- creation of new meanings that complement existing frames of reference
- transformation of points of view which occurs through reflection on currently held assumptions
- transformation of frames of reference or “habits of mind”

With the term “frame of reference” Mezirow means our understanding of the world based on the experiences, values and concepts we have incorporated into our mind. As key processes he basically describes the mental actions we conduct to store information.

- Reflection: beyond awareness, critique of assumptions
- Discourse: validation of conclusions reached by reflection, rational, requires open mind
- Action: not only behavior, but making decisions for oneself

According to Huber (Huber, 1991) change resulting from learning need not be visibly behavioral. But learning may result in new and significant insights and awareness that dictate no immediate behavioral change but of course effect later decisions. Taking this into account, the crucial element in learning is that the mind be consciously aware of differences and alternatives and have consciously chosen one of these alternatives. This decision must not be to reconstruct behavior but, rather, to change one’s cognitive maps, frames of reference or understandings.
For most, we will consider learning in this adult way of consciously gaining new insights. To complete the understanding of the learning process, I will briefly discuss another form of learning, which is not of a behavioral nature but does also not require any conscious effort. This form of learning is referred to as implicit learning. Reber (Reber, 1993) defines implicit learning as "the acquisition of knowledge that takes place largely independently of conscious attempts to learn and largely in the absence of explicit knowledge about what was acquired". Because of its nature, implicit learning by individuals is very hard to influence and mostly relies on how and by whom information is presented. The learning individual itself is therefore not able to control this kind of learning. This is also, why this line of research today is considered a matter of software engineering and human computer interaction which are concerned with the providing of information for users. Although human computer interaction and software engineering will be discussed later in this paper, it is possible to preclude the ideas of implicit learning after reviewing the findings of Kato (Kato, 1996). The author shows with two case studies that we can make use of the functionality of implicit learning when designing human-computer interfaces. Since the human being is not only capable of learning explicitly presented information by the use of cognitive processes but also of incorporating structures and other information implicitly, corporate and personal learning can be facilitated by special prepared information presented by a computer. This special preparation of the information is necessary to implement the implicit data the system is supposed to transmit to the user. Of course, this preparation process must be based on a clear concept and requires a lot of conscious effort by the programmer to get it right. Needless to say, because of this conscious engineering of “teaching” software, implementing features for implicit learning is very time consuming and therefore requires enormous additional funds. As Katos' case studies suggest, very little success has been achieved in this field. From an economic point of view, it does not yet seem appropriate for the time critical process of knowledge transmission to apply the principles of implicit learning for the use of information technology in this field.

Reviewing the above, one can see, that human beings are able to handle information in a conscious and an unconscious way, which are generally referred to as “explicit” and “implicit” or “tacit”. This distinction can be found later also in the discussion about knowledge.

2.1.2.3 E-Learning or one-person-knowledge

The subject area around computer supported learning is commonly referred to as e-learning. Being now aware how humans perceive their environment and information it is now the question how the different input channels can be supported by information technology. Eklund et. al. (Eklund, 2003) define e-learning as “a wide set of applications and processes which use all available electronic media to deliver vocational education and training”. According to them, the term covers computer-based learning, web-based learning, and also the use of mobile technologies. The Authors further state that successful learning does not only require quality instructional content but equally an appropriate context that includes its facilitation and an understanding of the learner.
this discussion, the word context clearly refers to the learning environment facilitated by software programs. Eklund et. al. hereby imply that the fields of software engineering and the related human computer interaction must be aware of their subconscious influence on human learning and therefore include the findings of psychology in this matter in their work.

From a practical point of view, Guttormsen et. al. (Guttormsen, 2000) state on the basis of a literature review, that most people prefer voice to text and prefer voice in addition to text, even when it doesn't improve their performance. The preference for the audio channel is based on the less effort necessary for perception with this channel. Since it is possible to study a picture and simultaneously listen to additional spoken information about it, voice can extend the information content of a picture. Guttormsen et. al. argue that pictures can represent complex information at a glance, but they also clarify that the quality of a picture can vary greatly.

They present three functions which pictures can perform in a text:

- interpretation: to make difficult text easier to understand, the picture can give a context
- organization: explaining the structure of the text, illustrate functionality
- memorization: visualization of concepts and relations between aspects in text

Referring to psychological findings, Guttormsen et. al. add that an overload on one sense modality causes overall tiredness and reduced attention. For the principle of combining more perceptive channels to present information, a balance between visual and auditory information reduces the cognitive load and therefore ensures a complete and constant transfer of information.

Of course, some media are more suited to present certain information than other. Therefore, the media selection should match the type of information presented. Guttormsen et. al. propose to select the type of media based on the static or dynamic aspects of the information. Hereby, dynamically processes can be represented i.e. by animations in pictures or even movie clips. Static media like pictures and text on the other hand are more suited to represent static information.

Regarded from another perspective, computer aided learning (CAL) or e-learning also reflects the objectivistic and constructivist learning philosophies which contrast each other as extremes but are also combined during the human learning process (Guttormsen, 2000). The objectivistic philosophy is grounded on the idea that students learn by being taught and that knowledge is objective and exists independently of the student. This type of rational and conscious learning is mostly used for salient noncomplex performances. As a consequence, the knowledge that results from this type of learning tends to be more explicit and declarative. The constructivist philosophy incorporates the known learning by doing approach, which means that people construct knowledge by situating cognitive experiences in real live activities. This kind of learning is preferred by humans for complex tasks which are not salient. In this case, the developed knowledge may be somewhat intuitive, but it differs from knowledge emerging from an objectivistic approach because it is more consolidated and integrated.
These two types of learning are best supported by different types of computer systems. Simulating programs and systems which encourage free exploration and direct manipulation support the constructivistic mode where text based tools are more of an objectivistic nature.

Guttormsen et. al. summarize the different computer aided learning systems available today. They all incorporate one or more of the different learning principles discussed above:

<table>
<thead>
<tr>
<th>CAL systems</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulation-based</td>
<td>Provides a rich environment, a simulated world in which students may explore freely. Students learn by doing.</td>
</tr>
<tr>
<td>Tutoring systems</td>
<td>Students learn by individually following preprogrammed learning goals with the help of a computer. Knowledge acquisition is frequently checked by preprogrammed tests. Students learn by being told.</td>
</tr>
<tr>
<td>Hypertext and hypermedia</td>
<td>Hypertext organizes text as a network of nodes (pages, cards, and so on) connected by links (hyperlinks). The links enable unstructured navigation through the text. Hypermedia is a multimedia style of hypertext in which nodes may contain graphics, audio, video, and other items in addition to text.</td>
</tr>
<tr>
<td>Drill and practice</td>
<td>The computer acts as a tester and the student gives answers one by one.</td>
</tr>
<tr>
<td>Information</td>
<td>The computer presents the users with information on a special topic.</td>
</tr>
<tr>
<td>Distance learning</td>
<td>Students take part in a study program by accessing the teaching material via network technology.</td>
</tr>
<tr>
<td>Hybrid</td>
<td>A combination of different learning systems into one system.</td>
</tr>
</tbody>
</table>

For the decision on a set of integrated e-learning computer systems one does not only have to consider different types of media as discussed above, it is equally important to support both of the two possible learning modes to achieve a holistic solution.
Abbas et. al. (Abbas, 2004) conducted a case and literature research and identified the following key enablers for an effective E-learning. The single enablers clearly suggest, that E-learning can not stand alone in a company but has to be integrated and coordinated with human resource, information technology and knowledge management efforts.

- Seamless sharing of large pool of resources (information, storage, customized software/hardware and computational power)
- Support for a dynamic and continuously evolving set of participants
- Support for Service Oriented Architecture
- Support for dynamic content and resource management
- Intelligent indexing/match-making for resources and contents
- Standards for security and trust
- Collaborative tools for groupware management
- Knowledge Management
- On-Demand QoS

Abbas et. al. do not only call for an integrated approach to develop an e-learning system, they also warn to start over and try to develop such a system from scratch. They argue that such an approach would produce a system with limited integration capabilities which would also be less able to adapt to changes. For these reasons they develop a framework for a system which is able to incorporate existing technology and proposes additional components to fill in the gaps. Following this method, Abbas et. al. head for a fully integrated system.

2.2 On data, information, content, knowledge and wisdom

At the present time, knowledge is the driving factor of economy and is therefore widely discussed. In order to fully comprehend the upcoming discussion, a shared understanding of the most crucial terms is needed! Knowledge is often confused with information and dealt with at the same level. To prevent misunderstandings like this, I will derive knowledge and even wisdom from its roots in the following paragraphs.

The development of knowledge is best demonstrated by the knowledge pyramid introduced by Aamondt and Nygard (Aamodt, 1995).
As one can already expect from the headline of this chapter, data evolves to information, which itself progresses to content. The last step in this progression is knowledge which is topped by wisdom as a special form of understanding. Aamondt and Nygard however do not consider content in their discussion on knowledge evolution. But since the concept of knowledge is still not sufficiently defined and the idea of content gives considerable insights to knowledge sharing practice, which is the focus of this paper, I will consider it later on in this chapter. At this point, it shall only be stated that the concept of content does not interfere with the knowledge pyramid and the ideas of Aamondt and Nygard.

Here, knowledge is derived from scratch. The first element is still data. Data is defined as symbols or a collection of symbols. Clark (Clark, 1996) defines symbols as being associated with an object by rule, like a word describing an object. These symbols comprise of one or more signs. In any case, data is defined as being out of context and totally without meaning (Kaipa, 2000). These symbols can represent completely different information depending on how we interpret it. The initial step of all knowledge creation is therefore the interpretation of data.

This interpretive process in terms of putting conventions on data first produces information, which contains not only data but also its relationships. In terms of language for example, such a context would be the syntactic rules which are used to put symbols, which constitute raw-data into an order. Information is therefore an objective description of data.

The product of the subjective interpretation of information is knowledge. This transformation is carried out by the process of learning, described earlier. During this process, the information is brought into a subjective context by a human being. At this point it is important to distinguish between this context and the context that has been applied to data a few steps before, which is basically just a structure for data. The context humans apply to information involves a more flexible view on things including
also a more abstract view and classification of the information at hand. But the context
this information is now seen in, involves also prior existing knowledge and experiences a
human mind connects with this new information.
This knowledge we derived from a particular piece of information is now dependent on
the context we perceived it in and on our experiences which we share with nobody else.
It is the understanding of one human being of this particular piece of information.
Kaipa defines these six key characteristics of knowledge:

- Subjective as opposed to objective
- context sensitive
- collective and personal components
- tacit and explicit nature
- limited usability life, infinite life as a piece of Information
- functional when applied, informational, when acquired.

The Author also points out, that, since knowledge is “making sense of information”, it is
mostly the property of the person who is interpreting, than the property of the data that
has been interpreted. This is especially important, because numerous studies have been
conducted, showing, that every individual is most likely to find its different interpretation
of one and the same data. In addition to the six characteristics of knowledge shown
above, Kaipa attributes also cultural features to knowledge. This is, because we apply
our own principles and values while interpreting information. The most famous cultural
influence is the one introduced by Nonaka and Krogh (Krogh, 2000) who talks about the
role eastern and western cultures play for this process. But the knowledge creation
process is not only dependant on external factors. An individual itself may also develop
different interpretations of information, since this process relies on already existing
knowledge with a person. Therefore the meaning of information changes with the degree
of understanding, we have of our environment.

A very common association with knowledge is scientific knowledge. It comes from
research groups and laboratories of both, universities and companies. This kind of
knowledge is created by using scientific methods and standards. It is tested and
validated by other scientists. We can find it explicitly pronounced in online research
libraries or as paper copies in university libraries. These research reports and books
constitute a clear expression of the now knowledge and are accessible to everyone who
would like to read it. Since there is no problem accessing this kind of knowledge I will get
to an other association we have with the term knowledge.
As discussed above, knowledge is also derived from information taking into account the
experience a person has. This is the other kind of knowledge, which is not produced
using validated formulas. This kind of knowledge is associated with an experienced
(expert) person. Obviously it takes a lot of time and different memories to build this kind
of knowledge which enables a person to act in the right way on account of these
memories and the facts learned from these situations. That’s what we understand also
as knowledge. Unfortunately, it is very difficult to describe this knowledge explicitly since
a lot of different memories and emotions are involved. This is why another distinction of knowledge is commonly used to describe this problem. This rather vague description of the confusion about different kinds of knowledge will be rendered more precisely in the upcoming paragraphs.

Psychologists distinct knowledge in terms of tacit and explicit knowledge. The following description is taken from an online dictionary of the Washington University in St.Louis\(^1\).

“The distinction between tacit knowledge and explicit knowledge has sometimes been expressed in terms of knowing-how and knowing-that, respectively (Ryle 1949/1984, pp. 25-61), or in terms of a corresponding distinction between embodied knowledge and theoretical knowledge. On this account knowing-how or embodied knowledge is characteristic of the expert, who acts, makes judgments, and so forth without explicitly reflecting on the principles or rules involved. The expert works without having a theory of his or her work; he or she just performs skilfully without deliberation or focused attention. Knowing-that, by contrast, involves consciously accessible knowledge that can be articulated and is characteristic of the person learning a skill through explicit instruction, recitation of rules, attention to his or her movements, etc…. “

The abstract cited above is right about the description of the “knowing-how”, the expert knowledge so to say. The other knowledge, the “knowing-that” is often not clearly differentiated from data, as noted by Helmut Willke (Willke, 2001). He claims “knowing-that” corresponds often with declarative knowledge and therefore constitutes simply data. It is the same with the misleading terms “statistical knowledge” and “fact knowledge” which also refer to data. Based on the above, Nonaka and Takeuchi (Nonaka, 1995) define tacit and explicit knowledge as follows. Their understanding of these terms will be adopted for the further discussion in this paper.

“Explicit knowledge can be expressed in words and numbers, and easily communicated and shared in the form of hard data, scientific formula, codified procedures, or universal principles. Thus knowledge is viewed synonymously with a computer code, …. or a set of general rules.”

“Tacit knowledge is highly personal and hard to formalize, making it difficult to communicate or to share with others. Subjective insights, intuitions, and hunches fall into this category of knowledge. Furthermore, tacit knowledge is deeply rooted in an individual’s action and experience, as well as in the ideals, values, or emotions he or she embraces.”

Nonaka and Takeuchi consider explicit knowledge to be only the tip of the iceberg, with tacit knowledge being the more important skills. This kind of knowledge is manifested in action, experiences and contexts of various kinds. In addition to this insight they subdivide tacit knowledge into two dimensions. Regarded from a technical point of view, tacit knowledge contains technical skills which and the knowledge we mostly think of ass

\(^1\) [http://www.artsci.wustl.edu/~philos/MindDict/tacitknowledge.html](http://www.artsci.wustl.edu/~philos/MindDict/tacitknowledge.html)
know-how. But it also comprises cognitive components like schemata, mental models, beliefs, paradigms and perceptions.

Based on the understanding of knowledge as Nonaka et al. cultivated it, Preiss (Preiss, 1999) continues to define knowledge more in terms of “inside” or “outside” a human being. Generally he sees knowledge as: “a collection of data and of rules and relationships that enable one to create new data or new rules from a given collection of knowledge”. Going on, Preiss equals explicit knowledge with information, which is a practical point of view from a knowledge management perspective. This is generally consistent with Nonaka’s definition of explicit knowledge which in itself states that explicit knowledge is very easy to express and is already supported by a broad variety of information systems like data bases and intelligent search engines which implementation is only a matter of skilled programming and mathematics. The support of explicit knowledge through information systems shall therefore not be investigated further in this paper.

Instead, I will focus on the possibilities of supporting tacit knowledge through the use of IT. According to Nonaka and Preiss, tacit knowledge comprises not only of data and relationships but also of personal components like hunches and experiences and constitutes therefore a highly intangible asset, which is a quality that poses great difficulties on the support through information systems.

Further developing the knowledge process, Kaipa (Kaipa, 2000) places great importance on self-knowledge. As mentioned above, the interpretation process is based on our own set of standards such as values and principles that we acquire, mostly unconsciously, from several sources such as family, religion, culture, media, and society. The Author claims that “the gap of understanding oneself prevents us from breaking out of inertia and taking action”. He sees the solution for this problem in the understanding of our own dilemmas and guidance systems which should finally lead to a better understanding of the principles by which we live. The untroubled self is in accordance with Kaipa more likely to interpret information concisely.

Much like the quest for nirvana in Buddhism, the reflection on oneself to gain self-knowledge is supposed to finally lead to wisdom, the ultimate form of understanding. For Kaipa, “wisdom is about discernment and flow between integration and discrimination”. For Ackoff (Ackoff, 1996) on the other hand, Wisdom is the ability to perceive and evaluate the long-run consequences of behavior. He distinguishes between knowledge and wisdom using Peter Druckers distinction between doing things right and doing the right thing. Therefore Ackoff states, that knowledge primarily is about efficiency while wisdom is about effectiveness.

Bierly et Al. (Bierly 2000) propose not only experience, but also spirituality and passion as the way to wisdom, which they define as the ability to best use knowledge for action. Judgment and action are considered as core elements of wisdom. In their opinion, wisdom is not only the result of rational analyses but incorporates also an even amount of integrity, personal truth and reflection. In this case experience is understood as a means of understanding and incorporating new knowledge based on a trial and error approach. Spirituality as a path to wisdom must not be understood in a religious way.
here. The Authors hereby understand morals and the self-knowledge with the same meaning as in the concept of Kaipa. Spirituality is believed to enhance wisdom by providing clear goals and the underlying core beliefs. Bierly et Al. cite Beck (Beck, 1999) defining Wisdom:

“Wisdom is the science of the spirit, just as knowledge is the science of matter. Knowledge is separative and objective, whilst wisdom is synthetic and subjective. Knowledge divides; wisdom unites. Knowledge differentiates whilst wisdom blends . . . Wisdom concerns the one Self, knowledge deals with the not-self”.

Their own definition of wisdom is as follows:

"Wisdom is the ability to best use k for establishing and achieving desired goals and learning about wisdom as the proves of discerning judgments and action based on knowledge".

Bierly et Al. also discuss the importance of faith and also intuition as driving factors of knowledge based decision making. But since this paper is concerned with the sharing of knowledge, these ideas, although very interesting, must stay unconsidered.

Now I will come back to the idea of content which sometimes is a necessary step between information and knowledge. Flensburg (Flensburg, 2004) argues, that if a collection of data is described by some kind of structure, metadata, so to say, it does not necessarily mean, that there is no doubt about the meaning. Although we might have an idea about possible meanings, we can not decide for sure because of lack of the necessary background knowledge. This background knowledge can be regarded as metadata which helps us to fully understand certain information. It is the combination of metadata, describing the information and the information itself, what Flensburg defines as content. The idea of content will be of importance, when I discuss the knowledge sharing process among humans which heavily relies on a common knowledge basis between sender and recipient.

2.3 Information Technology

Guttormsen et. al. (Guttormsen, 2000) define Information systems as systems which present users with information on a special topic, where users can influence and specify the information shown. Such systems can have a simple structure, based on different cards in a data bank, for example.

This rather narrow view on information systems comprises only one segment of systems which can provide users with information. Users can be provided with information also without the active involvement of the user. Also with regard to the upcoming discussion on the support of the knowledge creation process by information technology, we must adopt a broader view of technology when concerned with knowledge. It is also important to understand, that except for information technology, which supports E-learning, almost all existing systems are used and intended for knowledge management purposes in an organizational environment. As we will see later on,
organizational knowledge management does not necessarily cover the entire knowledge process and so do knowledge management tools. Since most knowledge management infrastructures were set up progressively or have not been deployed for economic reasons, not every available technology can be found in a company. Also because of this development, different functionalities can be included once by a single system but also be divided up into several systems. Therefore, Mertins et. Al. (Mertins, 2001) divided the results of a survey of current knowledge management tools into eight different functionalities:

- Search engines, categorization tools, intelligent agents
- Portals
- Visualizing tools
- Skill management
- Complete KM suites
- Toolkits for developing individual solutions
- Learn and teach
- Virtual teams, collaboration

Additionally, Mertins et. Al. clarify, that these, explicitly knowledge related systems are not the only technologies that are able to facilitate the process. One must also consider technologies on which the tools, stated above are based on or rely on. This can be systems which create the necessary infrastructure like networks (intranets, internets) and servers or databases (physically). But as we will see later on, also e-mail and chat programs are enablers in the knowledge process.

To complete this section, I will list the different technologies, Mertins et. Al. found to be used in today's knowledge management.

<table>
<thead>
<tr>
<th>Technology</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intranet technology</td>
<td>Unified surface for distribution of knowledge from various sources</td>
</tr>
<tr>
<td>Groupware</td>
<td>Platform for communication within a firm, Supports cooperation</td>
</tr>
<tr>
<td>Electronic document management</td>
<td>Uses the feature of documents to store and spread knowledge, The use and maintenance of documents is supported</td>
</tr>
<tr>
<td>Information retrieval tools</td>
<td>Includes text searches, automatic categorization and summation of documents. Simple queries are complemented by advanced search algorithms, thesaurus, text mining and semantic text analysis</td>
</tr>
</tbody>
</table>
Workflow management systems | The business process carries knowledge, Theses tools provide means to control this flow
---|---
Data analysis | Collected data may contain knowledge, Pattern recognition, classification and forecasting are used to identify it
Data warehousing | Modern databases, standardized, subject oriented
Agent technologies | Based on artificial intelligence, Using personal profiles and several sources for information search
Help desks | Uses case based reasoning technology, Case insights can be put into use
Machine learning | Creation of new knowledge through artificial intelligence, Automatic optimization of processes
Computer based training | Incorporates multimedia applications, Knowledge is passed on to colleagues

### 2.4 Knowledge Management in general

In this era where traditional resources and manpower are no longer the main competitive factor it is commonly known, that knowledge has arisen to be the most crucial business asset today. Because of this importance it is inevitable for every organization to be in full control of this resource and to try to maximize its outcomes. These efforts are accumulated in the area of knowledge management.

Huber (Huber, 1991) makes a clear point, when he states that “as a result of specialization, differentiation and departmentalization, organizations frequently do not know what they know”. This specifies clearly the issues large specialized companies face today because they deal with almost unlimited complex subjects one human being cannot possibly be aware of altogether. This is at least one reason for an effort in knowledge management to bridge the gap between members of an organization which should belong together.

O’Dell et. al. (O’Dell, 1998) define Knowledge management as “the process of identifying, capturing and leveraging knowledge to help the company compete”. This definition already captures the very essentials on which today’s companies have to focus on to be able to compete in the global market with ever growing competition.
Agreeing, but with a more detailed view, Alavi et. al. (Alavi, 2001) understand knowledge management as referring “to a systemic and organizationally specified process for acquiring, organizing and communicating both tacit and explicit knowledge of employees so that other employees may make use of it to be more effective and productive in their work”.

Today knowledge in the meaning of expertise is a short resource and also the most important factor of production. As already stated above it is inevitable to manage knowledge. Of course, most managers will try to apply their experiences and ideas of management they gathered in traditional management fields to this new resource which is a great challenge. One could think that managing knowledge is no more than an extension of normal management activity. To protect oneself and the company from this fatal error one must first understand the theories and concepts behind this “new” resource. The following insights from Bach et. al. (Bach, 1999) view knowledge from a management perspective which is quite intriguing because most literature approaches the subject from a psychological perspective. Bach et. al. state that knowledge differs in many crucial ways from conventional resources that can be managed. On the one hand, it is less visible than raw materials, capital or work. On the other hand, once it is finally generated, it can be easily copied at very low cost. It can also be formally protected by copyright law. But even if knowledge is protected in form of patents and proprietary instrumentation, it must be explained and described. This way, other people and organizations can use this knowledge in own creation processes and revisions so that at the end, a totally new knowledge results. Although the knowledge is protected, it does not hinder innovation. In particular capital and knowledge differ in their marginal utility. Almost every good follows the rule of the diminishing marginal utility. This means, if one has already two cars, the utility of additional cars gets less with every one of them. With knowledge, it is the other way round. Here it is the rule of the increasing marginal utility. The more expertise an organization or person holds, the more it can gain from the additional knowledge. This is best illustrated by the example with the professor talking in front of high school students about high mathematical formulas... they don not know what he is talking about. But holding this speech in front of other professors and scientific staff and students is much more profitable for the listeners. All participating persons can deal with the difference in knowledge in an optimal way. This example clearly shows that managing knowledge is a completely different task than managing other resources. The work of this thesis hast to take all these complexities and differences into account.

On another account, the transfer of knowledge which seems necessary from a resources oriented and organizational point of view is highly problematic. Knowledge that has been proven to be valuable for one part of the organization is not necessarily right for other departments (Haun, 2002). As will be shown later, knowledge is highly context sensitive an also dependent on the holders experiences. Therefore it is misleading to think that what someone wants to communicate to somebody else must be relevant for the recipient. Especially in human organizations, the communication of knowledge implies that the receiver does not know enough or not the right information. This might be counterproductive since a lot of people can feel their professional reputation offended by this practice. Social sciences expect an open or at least hidden
dismissal of the knowledge that is tried to be communicated in an open attempt. This fact also makes the transfer of knowledge very difficult and demands very sensitive work from knowledge management.

Knowledge is in social terms, how a person or an organization defines itself (Haun, 2002). New knowledge is exclusively processed using existing patterns of thought. New knowledge that contradicts existing one is automatically rejected for reasons of self-protection. All attempts to manage knowledge have therefore automatically an influence of the identity of the object managed. Managing knowledge is the task to evaluate new experiences and comparing them to the existing knowledge. It needs a permanent re-evaluation of the knowledge and the decision if now knowledge should be kept and/or replace old one or be rejected.

Approaching the subject from a more technical point of view, for a successful knowledge management, the depicted knowledge must be stored in some kind of knowledge basis. Structure and design of the basis must reflect the different forms of knowledge and all the possibilities for its development, transformation and its use (Haun, 2002). Depending on the kind of company it will be used in, a knowledge basis is subdivided into different elements. Literature provides a number of possible divisions. A common one is the one provided by Probst et. al. (Probst, 1999) who propose eight different elements of Knowledge management which then in turn can be used to select various subsystems to support the corresponding knowledge management element:

- knowledge goals
- knowledge development
- knowledge distribution
- knowledge acquisition
- knowledge identification
- knowledge conservation
- knowledge assessment

These eight elements can be merged together on a higher level to get an overview. The three central elements then would be:

Knowledge generation
  Knowledge logistics
  Knowledge utilization

As mentioned above any method of knowledge processing and distribution depends on the right knowledge culture around it. It needs the cooperation of the participating parties. Gehle et. al. (Gehle, 2001) consider this to be the task of the higher company management. This is why in almost every bigger company there is a CKO (Chief Knowledge Officer) who is responsible for this central activity.
According to Gehle et. al., the CKO is also the head above the knowledge generation. In a general context this refers to the process of identifying and selecting worthwhile knowledge. Knowledge is “generated” in this sub processes: establishing a goal, identification of relevant knowledge environmental and internal scanning and finally the knowledge generation.

Having completed this task, the next step in an overall knowledge management is to distribute the identified knowledge to the correct recipients. This process is named knowledge logistics. It must be insured that the relevant contents arrive at the right time at the place of use (at the user). This can be done in two different ways which may be combined. Either to supply the user in an optimal way with knowledge corresponding to his responsibilities, called the push principle, or to support the user with his search for knowledge, called pull principle. In any case, there is always the problem of access rights and communications security. Some information might be security sensitive and must therefore be protected. On the other hand, this information might also be helpful for everybody. This need for security always hinders the collective development and a good usability of such a system.

A community must always work in collaboration on its knowledge. To ease this, Gehle et. al. (Gehle, 2001), argue that the knowledge should be standardized and a central authority must be responsible for the authorization of knowledge. According to Davenport (Davenport, 1997) knowledge management must not focus on the creation of knowledge which practically occurs automatically in the human mind but should be concerned with the capture and integration of this knowledge. Most other authors agree instead that also the creation of knowledge can be facilitated by organizational means and therefore incorporate the creation process in the whole organizational knowledge process, as will be shown later on.

Therefore, Knowledge management in consulting companies has to focus on the optimization of the acquisition, the distribution and the use of the intellectual capital present in the organization.

To support this process, knowledge management must cultivate and accompany the whole procedure. This involves the first emergence of knowledge over the manifestation to the use (Gentsch, 1999). The management concept must hereby reflect the whole system the knowledge is handled in. Important entities are the human, means of production like technologies, the organization, data, information and finally, knowledge. Applying this to a knowledge management system, Bach et. al. (Bach, 1999) need it also to be of a situate nature, taking into account all individual requisites and circumstances of the problem area. It must be also oriented towards the goal that the system should be of direct use for the user. Future developments should be anticipated as well as possible. Content and process orientation of the system ensures the acceptance of the organization even if cultural or structural changes occur.

To summarize, a knowledge management system shall provide the following features:

- system orientation
- situate
- goal oriented
- prospective
- content oriented
- process oriented

A knowledge management system does not only incorporate knowledge acquisition and distribution and a personnel database. Without the corresponding organizational culture such a system can only have a diminished effect on the enterprise (Gentsch 1999; Nonaka, 1994). Literature shows hundreds of cases where expectations on knowledge Management systems have not been met because of the missing corporate knowledge culture. Therefore, Knowledge should be incorporated as a plan able factor into the quarterly or annual Plans for the company. In there, the provisions concerning the knowledge must be defined. Then the company has already defined its area of knowledge. It is necessary to hold knowledge about this area because it is the basis for all ongoing business.

2.5 The consulting business

To be perfectly prepared to discuss knowledge in a business environment using consultancies as and example, it is a prerequisite to understand the special conditions that distinguish consulting firms from other businesses.

In general, consulting is understood as the help and work an external professional provides to an organization in order to solve an organizational or entrepreneurial problem (Haun, 2002). External help is often needed to overcome lack of capacity or know-how. A consultant also brings new methods and efficiency into a project, from which the organization can learn. It is also quite often, that an external professional functions as a mediator between different groups within the organization. Antal et. al. (Antal, 2001) summarizes the tasks consultants generally perform. Their main job is usually to bring new knowledge into an organization. This can be subject specific knowledge the consulting company developed for this purpose but consultants also acquire their expert knowledge from best practices they dealt with during past projects which might also have taken place at a competitor of the current client. Not at last because of this, consultants have to cope with a number of prejudices among their new client which can be of an emotional but also principal nature. Antal et. al. also identify another in literature mostly uncovered task of consultants. During their work at a client’s working place, external consultants are able to discover hidden internal knowledge within the clients firm due to their not preoccupied way to approach the problem. A third task consultants perform while being in a project with clients is probably the most important. Independent on the way new knowledge was acquired, they also have to ensure that it is applied and integrated into the client’s business processes. The acquisition of new knowledge usually results in a change in the companies routines. To achieve this change, new knowledge must be translated and incorporated in a proper manner, which is the expertise of the consultants. As a prerequisite for a lasting success of all these consulting interactions with client companies, Antal et. al. demand trust in the consultant – client relationship during the
learning process. Otherwise, the achieved change is likely to be disregarded after the project is terminated.

Consultants can work on levels of different complexity with a client organization. On a large scale, consulting is about transferring knowledge. In areas where the client has no business expertise, the consultant delivers explanations and specific recommendations for the future work in this field. These recommendations are based on the large scale business goals of the client. The business goals and the economic circumstances are the basis for the consulting process. These factors are analyzed and validated prior to the actual problem discussion. During this process, the consultant must acquire specific knowledge of the clients’ business area and combine it with his expert knowledge. Such general consulting tasks involve technical matters as well as subjects of the management-, personnel- or organizational field.

In a more detailed approach of consulting, external professionals are used to create a concept tailored for a specific problem situation. The merging of external knowledge with the available organizational knowledge is a powerful basis to create possible rational actions which can be taken to reach a business goal. From this pool of alternative ideas, the most suitable ones can be selected to form the final concept. A prerequisite for the successful creation of such concept alternatives and the concluding decision is the detailed knowledge of the problem area. More than during general consulting tasks, the consultant does not only have to be an expert in his field but also in the clients’ area of business. In the actual consulting process, it is not only the use of this knowledge but mostly the generation of new knowledge in the problem area that enables the creative and successful planning of a concept. The generation of new knowledge and complex concepts is mainly the result of the interdisciplinary cooperation of experts (know-how bearers), which is only possible if the experts understand each other. This kind of more specific consulting projects can be the planning of an information system the creation of a logistics plan.

In any case, as Götz et. al. (Götz, 2004) state, the key product of the consulting activity is always of an immaterial mental nature. These ideas and experiences are the resources of a consulting enterprise as opposed to a producing company, where patents or raw materials and manual labor are the basis of business. All these ideas and experiences in consultants’ minds constitute knowledge on a professional level. During the process of consulting, this expert knowledge is transformed by use of other knowledge, now in form of methods of problem solution and methodologies to new knowledge. As one can easily see, all that matters in consulting is about knowledge of diverse expert areas.

But the complexity and diversity of the knowledge involved is only one of the boundary conditions that make the consulting business different from other businesses. Consultancies have to cope with a lot of other factors that influence the daily work.

According to Haun (Haun, 2002), the human resource development for example is one of the most critical issues, because most of the knowledge is held by employees. Due to the high fluctuation of employees, the knowledge of these consultants must be documented and transferred to their co-workers. On the other hand, the relatively short time a consultant spends in the business, it is also necessary to ensure a quick and optimized transfer of the stored knowledge to new employees.

With the IT-sector being the fastest growing economy right now, consultants have to be always ahead of the upcoming trends and acquire the necessary know how to be able to
compete in the business. Affected by the fast aging technology, projects must be completed as fast as possible, otherwise, the desired advance in technology is obsolete and the results would not be cost effective.

These key factors which characterize the consulting business are simultaneously the most important factors in competition. In this area Knowledge is very volatile and gets quickly out of date. The reason for this characteristic is that the special knowledge is context sensitive and changes continuously since the relevant contexts change with the generation of new knowledge. This circle of changes in knowledge is maintained at high speed, since the search for new innovations dictates the success of every company participating in the market. Equally important like knowledge is the non-knowledge in consulting (Haun, 2002). It is the fact of not being aware of certain circumstances or situations which enables the consultant to explore the client system without prejudice and orientation. Their knowledge of their system often blindfolds the clients’ employees for the real problem, because they are used to their corporate practice. Therefore it is sometimes not only necessary to have more knowledge than one’s client but to have different knowledge. This way the merging of different knowledge to new one constitutes the real resource of consulting.

2.5.1 Consultants

The consultants’ career in one organization lasts for an average of around 9 years (Haun, 2002). He is hired after getting his university degree, at the end of his working life or after some years of experience in business. After some years in the consulting enterprise the expert becomes a senior consultant or a project leader. Only a few senior consultants advance into higher management levels. This average career shows why there is such a high fluctuation of employees in the consulting business. A consultant works most of the time neither in his home town nor in his company but at the clients’ place of business. He is also working several hours more a week than the average employee. This is also, why the client is charged for the work in man hours. In order to advance inside of his company it is very important for the consultant to be indispensable for the organization. Therefore it is not in his nature to share his knowledge. This behavior is grounded on normal social considerations which will be explained in detail in the chapter on organizations. On the other hand, it is a key requisite for this job to be socially skilled. This is very critical for the project work with other consultants and the clients’ employees. Social skills are the basis of bringing new knowledge in a harmonic way into an organization without being rejected instantly. A lot of consultants also work alone, do everything themselves and create work that has already been done, but unfortunately has not been shared. Here it is the most important task for the management of a consulting firm to encourage their consultants to share and work together with the whole company.
2.5.2 Knowledge Management for consultancies

Consulting companies need to fulfill certain requirements to be able to meet competition. They have to keep a lot of very purpose oriented potential solutions available for prospective customers to be able to act quicker than their competitors (Götz, 2004). This specific expert knowledge is the potential the company can work with and also identifies itself through it. The clients expect especially intuitive powers and a high competence in solving problems to be able to cope with any economical problem during a project. The customer also relies on the least amount of uncertainty during the execution of planning or consulting projects.

In addition to these customer expectations, it is also important, that all projects are conducted in an economically sensible way. According to Haun (Haun, 2002), therefore knowledge management must also fulfill the requirements which can be deduced from these claims:

- high effectiveness of the projects
- higher efficiency of the project work
- increasing of the economic capacity
- increased customer satisfaction

There is no room for project failure or ineffective outcome of projects. Consultants are important for the survival of the client organization. On the consultants’ side, every project affects the reputation of the company. In case there is no effect of the consulting activity, both, the client and consultant can be damaged irreparably. The key to avoid this lies in innovative solutions. But since there are also some risks involved with innovation, this process has to be carefully structured and systemically orchestrated. This action requires a broad previous knowledge.

In order to work efficient at the customers site, it is a prerequisite, that the own organization works in an efficient way. To increase the own efficiency, knowledge must be built up strategically and also be reused in a selective fashion (Haun, 2002). This can be achieved by a knowledge oriented deployment of the personnel. Hereby, knowledge carriers and inexperienced employees are in the same project staff and can now easily acquire new knowledge by learning by doing or simply by observation during the project work.

The image a consulting firm has is the most important factor in determining the price they can achieve for their services. In order to increase or at least maintain their image, consultancies must work on their efficiency. And, as mentioned before, knowledge is also a marketing factor and possesses itself a market value. Put together, higher efficiency and more knowledge enable the achievement of higher prices. Well in addition to that, the price-performance ratio must still be acceptable for the customer. This is most important, since one must not forget that customer retention is still a factor of success in knowledge based consulting. This is because subsequent projects can be conducted much faster and efficient on both sides, because the cost intensive initial project phases get shorter with every project.
2.5.3 Knowledge development

During the consulting activity, new knowledge is produced as a by-product. As the main goal remains still the actual consulting service concentrating on an innovative solution. In an industry, that is as highly dependent on knowledge as the consulting sector, it became very early common to develop new knowledge in advance of the projects. This is not at last because it constitutes an important factor in competition, as pointed out earlier. Following the work of Klaus Götz (Götz, 1999), we can distinguish from three different ways of developing knowledge:

- Development of knowledge from projects: during any kind of projects the positive, negative and – most important - the new experiences should be collected in special documents, widely known as “lessons learned”. There are a lot of different approaches to do this. Most projects have this activity at the end of the project. The problem with that is of course, that a lot of the experiences have settled into the mind by now and do not seem to be so new to the consultant. Therefore she will forget some of the “lessons” especially those from early project stages. To prevent this from happening, it is better to create “lessons learned” in every project phase, not only in the final debriefing stage. This way all project members can share their thoughts. Unfortunately it is a fact, that at the end of projects some participants have their mind already working at a new one or left the project because their part is already done.

- Generation from external and internal sources: There is a huge amount of databases available today. Some of them are online accessible and for free, or all this information can be purchased. Scientific institutions, universities and research networks also maintain huge libraries containing up to date facts on every imaginable topic. It is only logically to take use of this never ending source of information and also innovation. This can be the task of a special department in an organization to filter all these sources and find out new trends, generate new ideas and also take part in the active research with questions and answers. Another approach allows the consultants themselves as member of project teams to search themselves because it is them, who have the insights and the experience with their project problems that lets them know what to look for. Of course, exactly this preoccupation might hinder them from seeing beyond the end of their nose.

- Purposive knowledge development: Following this approach, consulting firms act more like an ordinary enterprise than like one would expect from a consultancy. It is because for the specific development of a consulting product or a system for a
special problem area the enterprises form dedicated teams that only work for this special purpose. They discuss and evolve specific products and develop them so that they can be put on the market not only for one customer but for various clients. Of course, the solution has to be tailored for every single client, but the main work on the product has been done and the company already holds a lot of knowledge about it and trained support is already available.

These methods are deeply connected with the project work that is done in a consulting enterprise. Depending on the company, the approaches may vary or be tailored on the firm. It is also possible to use the different approaches in parallel or mix them in a practical fashion. Anyhow, the whole process must be supervised and there must be some kind of controlling. Probably the controlling of these activities is the responsibility of a member of the project leadership or a member of the central department for knowledge management in the company. It is the job of this knowledge management officer to ensure the production of all related documents on which has to be agreed upon in advance. His obligation is further to collect these materials and deliver them to the central knowledge management processes which are of course predefined for the whole company in advance of each project.

3 The knowledge process

3.1 Human Knowledge Process

To be able to determine if information technology can play a supporting role in human and organizational knowledge sharing, I find it necessary to identify the earliest task in these processes that can be supported. At first, for a human to share knowledge, it is a prerequisite to have a certain amount of knowledge, which can be of interest to share in a business environment. This requires the knowledge to differ from general knowledge that members of a business enterprise are supposed to hold since they usually have passed comparable programs of higher education.

I established before that knowledge is the product of human thinking. A person's knowledge is therefore only this person's understanding of a specific problem or an idea. It was also stated that knowledge is subject to permanent change due to its dependence on frames of reference, which we use to elaborate on new information or on information we have stored. These frames of reference and therefore the knowledge that is based on them are only valid for the moment in time they were created by thought. With time, new information may come to our attention and we might change our frame of reference. Until now, psychology can not answer the question how exactly our understanding of the environment and all the cross-referenced information we possess is stored. Anyhow, the process of knowledge creation or thought is performed in the human mind on the basis of constantly changing information and frames of reference our background knowledge.
The process of knowledge creation is also dependant on emotions and personal experiences and makes knowledge therefore a highly personal feature. Being aware of this fact and the possibilities of modern information technology, it seems impossible at this time to implement the creation of knowledge from information into any kind of machine. All intelligent computer programs are based on simple algorithms and can, despite of their still growing complexity, be reduced to these algorithms. These algorithms on the other hand are still programmed by human beings and all input variables must be specified during programming. Unfortunately, this does not support the human knowledge creation process at all, since this creative process takes constant changing input into account. Based on this central task of the knowledge creation process, I conclude, that the process can not be performed by a machine. This does of course not mean that the process can not be supported by information technology. The thinking still has to be performed by a human being. But during this activity, the human mind relies on new information, or information that he has stored in his memory. The human also uses her emotions, self-knowledge and wisdom to perform this task. These components are even less understood than the knowledge creation itself and are additionally not only very human qualities but also of an almost supernatural level. We have failed until now to incorporate emotions into technology. Therefore, modern technology can support the knowledge creation process only by supplying information and also by supporting the storage and retrieval of information we store in our brains. Needless to say, it is only possible to enhance the storing and retrieval process of information we store consciously. Otherwise we would not be able to focus on the information that needs to be enhanced since we are unaware of their nature.

Possible facilitations of the retrieval process of information from the human memory storage trough information technology have already been discussed in the chapter on memory and learning.

In the following I will focus on the subject of how modern technology can support the supply of information to a human being. The preceding step of the creation of information from data can be neglected in this discussion, because of several reasons also described earlier. This process follows highly standardized rules i.e. the use of syntax in language or other applications of context to data. Artificial intelligence also failed in this matter to simulate this process since, as already established, it is highly dependant on internal human methods like frames of reference and still not understood mechanisms of assigning meaning to data. It might be possible to assign a number of meanings to specific data which would have to be hard coded by means of computer science first and would so be again limited to this number of predefined and programmed methods. But this method does not reflect at all the broad variety and flexibility of the human process. For this reason, this process of converting information from data stays exclusively a matter of human intelligence. The question is therefore if and how information technology can facilitate the absorption of information which is produced by oneself and other human beings. At this point it is necessary to draw the line between the principles of information and knowledge sharing, which will be discussed later and the reception of information by a single human being.

In an earlier chapter I established, that perception from a biological perspective can not be supported by electronic aid. The learning process however, which is based on the perceived information material can be facilitated by selected forms of multimedia presentations, as stated in the chapter on learning and e-learning.


3.2 Knowledge in groups

Trying to understand the evolution of knowledge in the individual to knowledge in organizations, one should try to understand knowledge in groups, which can be considered as small organizations.

Ngwenyama et. al. (Ngwenyama, 1997) characterizes collaborative work, in the sense of group work, as "a web of coordinated actions, performed by the participants to achieve a joint outcome". Collaborative actors only believe that by participating in and contributing to the common action they can promote their individual goals. This is also the explanation for cooperation between actors whose goals differ. Collaborations between competing firms for example are of course not their major goal but are necessary to promote the success of the single participating company. Anyway, this argumentation clearly shows that group work is driven to a large extend by social factors.

For this reason one should investigate the psychological perspective on groups as provided by Buchanan et. al (Buchanan, 1985). They consider a group as a social system which is dependant on the physical, cultural and technological features of this environment. The environment imposes certain activities and interactions on the people in its system which then arouse a feedback, which itself is dependant on the reactions of other members of the same system. This external system which makes some people share a common frame of reference induces an internal system which is interdependent due to the interaction described before. These considerations suggest that group work and on a larger scale also corporate work must not be investigated without consideration of the environment the actions take place.

Groups of course grow and develop. The members come to know each other and trust each other. As a consequence, intuitive behavior enhances efficiency. During the development of a group, behavioral norms are developed. A group is practically a small society including norms and traditions. But Buchanan et. al. also recognize that these rules and norms are subject to change and adjustment. If the group starts to change on its own, it induces coherent change in the environment it interacts with. Following this principle, as groups are influenced by the environment they are in, groups also influence their members. Of course it also works the other way, since it is a constant interaction, which means that the members of a group are not only influenced but have an impact on the group themselves. This is again a reason to include the environment even if the focus of research is directed at a single individual.

In such a context, for sure, the question arises if such a network has own productive qualities or if the participants just sum up their workforce. Weick et. al. (Weick, 1993) proposed the model of the collective mind. This collective mind is built, when several individuals work closely as a group over long time and therefore have common experiences which in a sum constitute a common memory, shared by all the members and each of the members is held responsible for remembering her specific part of this common memory. Therefore, Weick et. al. suggest that members of a group hold community memory in addition or as part of their own memory as individuals.
Going deeper into this idea whether there is more to groups than just the sum of its members, Maier et al. (Maier, 2001) provide a very detailed description how knowledge can be seen in a group situation. They support the idea that a group of individuals is generally able to hold more knowledge than one individual itself. To accomplish this, the group unconsciously designates experts for certain areas of expertise who then are held responsible for storing information which relates to this area. This way, not every individual must store all information but only the information which of her colleagues is the expert for a subject. This is basically a system of references to sources or dumps of information within the group. This system is also used to encode new information into the groups' memory. Information which might be of interest for one of the groups experts which is perceived by another group member is forwarded to the corresponding expert and evaluated and interpreted by him. Through this transaction between group members which usually incorporates a discussion and therefore a lot of thinking, the encoding of information into everyone's mind is performed much better as if a single person would elaborate on this information. Also the recall of information is facilitated by this group activity, since the individuals can give each other cues to find the information in their minds much faster. There is also the possibility to correct false retrievals by comparing different outcomes of this process.

As mentioned earlier, a group of individuals has also a basic set of thoughts and conventions, their group culture. Despite the facts described above which make group memory superior to the memory of a single individual, there can also be some inhibitors on the group performance. Usually, groups need a certain level of harmony for serious work, but exactly this harmony could be disturbed by new information and ideas which conflict with the current beliefs. For this reason, an individual member of the group might withhold new information from the group. To solve this dilemma, the culture of the group should encourage advances and support productive criticism. Another reason which negatively distinguishes group memory from the single mind is that not all information is in one storage but divided onto several individuals. Maier et. al. see several reasons that during discussions and decisions, important information is not retrieved and incorporated, because for example, the member holding the information is not present or is simply not aware of the importance.

Finally, according to Maier et. Al., groups often suffer from the so called “process loss” which means the time and energy which has to be put up to coordinate the actions of the group and its members.

Vick et. al. (Vick, 2005) explains the emergence of new knowledge in groups to occur through discourse. Discourses among group members are based on very fragmented, non-linear operations. To technologically support the groups' knowledge creation platform, the applied systems must reflect this fragmentation and facilitate the different channels used by the participants. Vick et. al. demand a full support of the complex emergent knowledge processes in groups.

Anyway, as a prerequisite of these supporting activities, according to the authors, teams must develop a common understanding before effective interaction among the members can take place.
3.3 Organizational knowledge process

3.3.1 Organizations

Approaching organizations from a general perspective, Buchanan et. al. (1985) define organizations as social arrangements for the controlled performance of collective goals. Yet they clarify that organizations themselves do not have goals, only people are capable of having goals. Although managers decide on objectives for the organization and call them organizational goals, they are still the goals and ideas of those persons who came up with them.

And also, all members of an organization seek to achieve their individual goals which are mostly different from the collective purpose, since they might only be part of the organizations for financial reasons (employment) or for social reasons (power, self esteem). Often in organizations, the individual needs conflict with the organizational ones.

With these problems ahead and knowledge being the most important factor in business, Harrison (Harrison, 2000) is correct, when she concludes that failure to encourage and teach personnel to transmit their knowledge to other members of the organization will lead to serious problems during competition in today's global market. Seemingly, there is a great need for intra- and inter-organizational learning and knowledge sharing.

Organizational knowledge

Up until this point I considered knowledge only in terms of one human being or between human beings. Knowledge was defined as being subjective and highly personal. But as also stated above, in a corporate setting, this human knowledge emerged to the most important asset of a firm which is why the term “organizational knowledge” is used throughout the literature despite this misleading preoccupation. Anyhow, it is understandable, why this term has been chosen because companies consider the knowledge of their employees as their asset. Since the personal knowledge as I discussed it so far clearly conflicts with the idea of it being an organizational feature, a clear definition of the term is inevitable.

One could describe organizational knowledge first as the sum of all the knowledge of an organization’s members. But clearly, there must be more to organizational knowledge than this accumulation. Boer et. al. (Boer, 2002) suggest that “a collective mind is formed when people in close relationships enact a single memory complete with differentiated responsibilities for remembering different portions of a common experience”. This finally means that a collective mind and organizational knowledge coexist additionally besides the single human minds and knowledge.

Ackerman (Ackerman, 2003) provides the following definition of organizational or collective knowledge: “rules, procedures, strategies, activities, technologies, conditions, paradigms or frames of references around which organizations are constructed".
In a more activity oriented approach, Orlikowski (Orlikowski, 1996) defined organizational knowledge as follows: “Organizational knowledge consists of sets of routines as well as of experiences arising from the application of routines and the necessary improvisations such an application necessitates”. This view of organizational knowledge incorporates experiences and reflection on occurrences and past doing like the view of human knowledge does. The major difference in this case is the basis on which it is reflected on, the organizational routines. Feldman (Feldman, 2000) sees routines as "recurring patterns of behaviour, which incorporate chunks of past organizational knowledge for getting things done". Routines are here seen as the important work orders to achieve the organizational goals. Feldman’s definition also takes into account the possibility of change of the routines through their executors. Like people elaborate on pieces of information to create their own subjective set of knowledge, here they here use their professional skills to modify organizational routines as a reaction of previous iterations of the same occurring routine. Putting together the ideas of Feldman and Orlikowski, organizational knowledge is indeed comparable to human knowledge, with the differences that there is not only one actor, but all the members of an organization and the basis for knowledge creation is not a piece of information but an organizational routine, the actors are involved with and therefore can reflect on together.

Organizational memory

Similar like the term knowledge is adopted for describing properties of organizations, also the term memory is used to explain organizational features. Organizational memory is much like human memory a collection of information. Only here, most literature does not regard the information which is hold in human brains, but information which is stored outside of the human brain in repositories owned by an organization. This includes written documents, procedures and other structured information. Stein et. al. (Stein, 1995) classify organizational memory into two types, semantic and episodic memory. Hereby, semantic memory is understood as explicit information which can be found in written form or in databases of any kind. Episodic memory means information which is strongly related to a certain context or situation. This distinction reminds very much of the distinction between explicit and implicit knowledge, which is of course true, since these types of memory represent the means of storage for the corresponding type of knowledge.

Anyhow, Alavi (Alavi, 2001) notes that both of these types of memory and therefore also the electronic means of storing them can negatively influence the capability of the organization to create new knowledge. This is because electronically held material is not consequently erased upon arrival of recently verified knowledge to the same topic but resides for long time next to the new knowledge and confuses individuals, which rely on the correctness of the knowledge.

Like presented before, individual learning and knowledge are amplified even more, the more participants are involved in the process. Maier et. al. (Maier, 2001) apply this view on memory and see organizational memory basically as kind of group memory only in a much larger scale. They point out that the different departments of a company
correspond to the experts in a group and since they are a group themselves, this enforces their capabilities to handle knowledge of their business area. Aside these advantages, the single members of these specialized groups are even less accessible than group members to each other, which Maier et. Al. pointed out to be a disadvantage in information retrieval. To ensure that the company can work even there must be doubt about the best quality of decisions of specialized groups, Maier et. al. find it a matter of management to ensure a climate of confidence in these groups throughout the company.

Learning organization

At least, some authors accredit the organization with the ability to learn. Where organizational knowledge as a term is not used, it is substituted by the term “learning organization”. O'Dell et. al. (O'Dell, 1998) hereby describe an organization which can analyze, reflect, learn and change based on experience. O'Dell et. al. supposedly think of the members of an organization in this case, since at least learning and reflecting are solely human capabilities. This is also like Boland et. al. (Boland, 1994) understand cognition in organizations, which as discussed in an earlier chapter a synonym for learning. Boland et. al. describe organizational learning as "a distributed phenomenon, in which individual members of an organization reflect upon their experience, make plans, or take action". Different from O'Dell et. al. they clearly draw the line between the term "organizational learning" and the learning, performed by an individual person in an organization, from whom they say that only they are capable of creating interpretations and of testing understandings as an effect of their thinking and learning in their organizational setting. Boland et. al. consider the coordinated outcomes which are created, when single members think and act incorporating other members of the organization and their interdependencies to be organizational knowledge. They regard members of an organization as autonomous agents who act independently but which are aware of their interdependencies. Along those interdependencies, one's interpretations, or knowledge so to say, are exchanged and this way become a basis for a common understanding and basis for action. Based on the knowledge, that only humans are capable of knowledge creation, Boland et. al. conclude that information technology should be used to support the individual during their interpretation of their situation, their reflective processes and to facilitate the dialogue between the members of an organization. Out of this background, they define a distributed cognition (learning) system as follows:

“A distributed cognition system supports interpretation and dialogue among a set of inquirers by providing richer forms of self-reflection and communication.”

To prove their point here, Boland et. al. provide a series of case examples in which decision support systems narrowed the information that would have been available and could therefore not been considered as an alternative solution. Hereby they clearly show that deciding and reflecting should be done by humans. Information storage and communications support on the other hand are tasks which can be supported by information technology.
Being clear, how learning occurs in organizations, it is of interest how the consultants' role affects the organizational learning process. As explained before, consultants are hired to help an enterprise to improve performance or to solve a specific problem. Gherardi et. al. (Gherardi, 2001) argue that both of these tasks require the participants to learn during this process, even though learning is not a primary goal and the client might not even be aware of it. The organization learns since the expected result of the consulting activity is a change in an organizational process or in other words, the organizations' behavior. The consultant is requested if there is a need to do things different or if something new has to be done. Both of these cases constitute a change in behavior.

Back to organizational knowledge

In an attempt to clarify the difference between human individual knowledge an organizational knowledge and how they are connected, Crossan et al. (Crossan, 1999) present a basic overview of the dynamics of knowledge transfer and learning across individual, group and organization levels. At the individual level, intuiting and other activities like recognizing patterns and possibilities occur as part of the knowledge creation in an organizational setting. The results of intuiting are accumulated as experience, images, and metaphors, and are shared with other group members by the means of language, cognitive maps and dialogue. At this group level, all the individual processes reoccur within each member but are instantly merged together which process can be described as interpretation by all the participants. These interpretations are further integrated among members to form shared understandings and mutual adjustments. At last, after a longer period of time, some of the persisting integrated understandings are institutionalized into organizational artefacts, such as organizational routines, rules and procedures, and information systems. Although at the end of this process organizational knowledge is created, it is still dependent on intuition and interpretation of organizational routines by humans. Since this intuitive and interpretive tasks are crucial for this creative process, organizational learning and knowledge must always be seen in a social context incorporating the individual and its knowledge creating process. Again, these authors underline the importance of the individual and its social interdependencies for the knowledge creating process in organizations.

From the above, it is clear that a persons' actions are the direct product of his knowledge. On the basis of this fact, Brown and Duguid (Brown, 1991) argue that detaching knowledge from practice leads to misunderstandings and misinterpretations of the knowledge. Based on this theory of actions being the practical representation of knowledge, they further conceptualize organizations as a collection of overlapping communities of practice. Learning and therefore the acquisition of knowledge is not primarily abstract and individual, but knowledge is created and learned as part of the membership in a group. Following this idea of communities of practice, Lesser and Prusak (Lesser, 1999) consider these institutions to be the cornerstones for creating, sharing and applying organizational knowledge. They claim, that Communities of practice are "formed by
individuals who need to associate themselves with others facing similar issues and challenges within the organization”.

Based on this understanding of organizational knowledge, Bierly et. al. continue to project the concept of wisdom onto the organization. They define organizational wisdom as: “the judgement, selection and use of specific knowledge for a specific context” which of course means again the members of an organization and their ability to choose and apply appropriate knowledge in certain organizational situations. A prerequisite for organizational wisdom is hereby personal wisdom of the members of an organization. Bierly clarifies that the organization does not become wise unless the individual’s wisdom is articulated and transferred to other members. This is because the acceptance and possibility of decisions based on organizational wisdom relies on a common basis of knowledge and wisdom and must therefore be shared among the members first. To enable this appreciation and understanding of each others ideas, Bierly et. al. state the need for a transformational leadership and a supporting organizational culture and structure to share the knowledge among members to become the common basis.

Continuing from the thoughts above, organizational learning and organizational knowledge should always include all members of an organization, to make all of them carry and support the new idea. Because of this holistic approach, Kuwada (Kuwada, 1998) finds organizational learning, or strategic learning, as he calls it, to be a very effective tool for controlled strategic change in the organization. In fact strategic learning is considered to be a prerequisite for successful strategic changes. These changes again can be a planned consequence from the knowledge creating procedure or may of course occur involuntarily as a result.

One general, yet easily comprehensible view of the organization as a knowledge creating system is provided by Alavi and Leidner (Alavi, 2001). They propose a framework for the organizational knowledge management process based on which it is easy to identify possible IT support for the sub processes. The authors are correct when they additionally state that these sub processes shall of course not be enacted separately from each other but have to be integrated into a holistic system, agreeing with Nonaka (Nonaka, 1994) at this point.

The organizational knowledge management process here is comprised of four sub-processes which are:

- creation of knowledge
- storage and retrieval of knowledge (organizational memory)
- transfer of knowledge
- application of knowledge

For the first step process, the creation of knowledge, the authors adopt the view of Nonaka (Nonaka, 1994) which will be also discussed in this chapter. Despite their concerns on organizational memory Alavi and Leidner recognize that this is of course a
necessary component of the organizational knowledge process and see certain kinds of
groupware, modern computer storage technologies, and retrieval techniques like query
languages, multimedia databases and database management systems to be effective
enhancers of organizational memory.
Alavi and Leidner find that the challenging task of transferring knowledge is to enable
the communication of individuals with different individuals of the organization other than
their coworkers from their workgroup. As established before, they share a common
knowledge ground through their day-to-day activity and are therefore less likely to have
information to a special problem. For this reason, information technology is needed to
facilitate the communication of members of an organization which probably do not know
each other and are situated at different locations. On the basis of the corporate
computer network, electronic bulletin boards and discussion groups should fill this gap.
The most common representative of such discussion database software is probably
Lotus Notes. But of course, there is a broad variety of other knowledge maps, corporate
directories and intelligent agent software which use online boards, electronic mail and
video software to enable communication of diverse members of organizations mostly
related to a certain topic.
The application of knowledge is the most critical area for applying information systems.
Alavi and Leidner propose to use information systems to facilitate efficient handling of
routines by codifying and automating them. But they also note, that workflow automation
systems like these represent routines which are embedded into a always changing
environment and must therefore be regularly verified since the coding of a routine into a
software program hinders the evolvement of the routine unless the software is adjusted.
Information technology can also be used on a less critical level to capture organizational
directives and to make them accessible through the intranet of the organization. An
Intranet also enables the fast deliverance of the newest insights of different
organizational groups to others.

Ikujirō Nonaka being a great critique of western corporate culture complains that “few
managers grasp the true nature of the knowledge-creating company...they
misunderstand what knowledge is and what companies must do to exploit it” (Nonaka,
1992). Based on his theories, he clarifies that knowledge always begins with an
individual, even if it emerges to organizational knowledge later on. Therefore Nonaka
(Nonaka, 1992) favours the Japanese approach to make use of the insights, intuitions
and hunches of individual employees by making these hunches available for testing and
use by the company as a whole. Key factors for this process are believed to be personal
commitment and a supporting corporate culture. This understanding is grounded on an
other fundamental insight. Nonaka sees companies not as a machine but a living
organism. Much like an individual, it can have a collective sense of identity and
fundamental purpose. This constitutes the organizational equivalent of self-knowledge
mentioned in one of the earlier chapters on knowledge (2.2).
Altogether, Nonaka supports this understanding of organizational knowledge creation:
“the process that organizationally amplifies the knowledge created by individuals and
crystallizes it as part of the knowledge network of the organization” (Nonaka, 2001).
Ikujiro Nonaka and Hirotaka Takeuchi were the first to provide a new integrated theoretical framework for the creation of organizational knowledge (Nonaka 1992, 1994, 1995). Their model tries to incorporate all elements of the knowledge creation process and regards them from an epistemological and ontological point of view. Especially from the epistemological point of view, knowledge is mostly regarded to be nonhuman and more of a formal logic to be able to explain something. Nonaka considers knowledge as: “a dynamic human process of justifying personal belief toward the truth” (Nonaka, 2001). On the epistemological level it incorporates the well known dualism and distinction of tacit and explicit knowledge which has been explained in an earlier chapter on knowledge. Nonaka and Takeuchi argue that the conversions from tacit to explicit knowledge and vice versa are the key of knowledge creation. This is a rather logic conclusion considering that these conversions represent the different possible transfers of knowledge from one individual to another, meaning that a common ground of knowledge is created among individuals belonging to an organization. The four modes of knowledge conversion occur when tacit and explicit knowledge interact with each other. Organizational knowledge creation is therefore the product of the system of the four conversion ways: **Externalization** (triggered by dialogue and collective reflection), **Combination** (triggered by networking of k between different parts of the org), **Internalization** (by action or learning by doing) and **Socialization** (building field of interaction, sharing experiences and mental models), which will be discussed in detail later on.

On an ontological level which is concerned with knowledge creating entities, the description of a sensible context around them and the creation process itself, Nonaka identified four possible fields of action: individual, group, organization and inter-organization.

Just to complete the model of organizational knowledge creation of Nonaka, the author includes time as a 3rd dimension to these numerous interactions and creates the “spiral of knowledge creation” based on this two-dimensional process (Nonaka 1994). This so called "spiral model" will also be discussed in the upcoming paragraphs.

But at first, the knowledge creating process starts with the individual trying to transfer her knowledge to another individual. This is always a social process between humans, since Nonaka (Nonaka, 1994) clarifies that “an individual is never isolated from social interaction when he or she perceives things”.

The following table describes the four ways of knowledge creation in a company presented by Nonaka 1994:

<table>
<thead>
<tr>
<th>transition from</th>
<th>tacit knowledge</th>
<th>explicit knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>tacit knowledge</td>
<td>socialization</td>
<td>externalization</td>
</tr>
<tr>
<td>explicit knowledge</td>
<td>internalization</td>
<td>combination</td>
</tr>
</tbody>
</table>

**Figure III The four knowledge creation modes by Nonaka**
Socialization means here, the classical method of the students’ acquisition of the masters’ knowledge through a common working experience. The student hereby observes and then imitates the master under his supervision without too many instructions. The two opponents hereby share a common experience and new knowledge is created in form of a mental model and eventually new technical skills.

Externalization on the other hand is based on direct instructions. Explicit knowledge can be created by sequential use of metaphor, analogy, and modeling (see details of this method in the chapter on knowledge sharing, 3.3). By simple use of the analytical methods of deduction and induction one can also express his tacit knowledge explicitly in form of concepts or hypotheses. This is necessary for the organizational knowledge creation process because only this explicit pronounced knowledge can be used as a basis for

Combination, which describes the organizational acquisition of explicit knowledge. This form of acquisition is used in cases, where organizations are too big, too distributed or too fast for socialization. The process involves the systemizing of learned concepts into “knowledge management systems” and the reevaluation and correction of existing records of explicit knowledge.

Internalization, finally is based on different forms of individual and social learning. It is the individual acquisition of new knowledge as an implicit one. In parts, it is operational knowledge, that was learned through combination and one is now experienced with it and has internalized it, hence the term. This form of knowledge transfer is often referred to as “learning by doing”. From here, the internalized knowledge must again be socialized with other organization members to restart a new spiral of knowledge creation through the processes socialization, externalization and combination.

Harrison (Harrison, 2000) agrees with Nonaka that the sharing of tacit knowledge is by far the most important issue in global competition today. Anyway, Harrison does not go as deep as Nonaka with the description of a knowledge sharing process and finds the idea of socialization to suffice to share subconscious tacit knowledge throughout the organization.

Ackerman (Ackerman, 2003) on the other hand proposes a similar cycle of knowledge creation also including steps of socialization, externalization, combination and internalization. He differentiates further knowledge sharing from knowledge acceptance in the organization. He finds the collective acceptance of new knowledge to be the most important step in this process.

In the following, I will describe the spiral model of organizational knowledge creation as proposed by Nonaka (Nonaka, 1994), which is supposed to amplify the achieved individual knowledge to organizational knowledge by the use of these four knowledge conversion modes described above. For a clearer understanding of the process I will exemplify it in a business environment.

At the beginning of the process one must think of a linear development, which has its starting point with the sharing of tacit knowledge among different members of the
organization. This interaction and sharing of experiences and mental models is necessary, because in organizations, tasks are generally performed based on a common understanding, which requires the different members to have a common knowledge basis. This process is basically comparable to the socialization mode.

In a second phase, the externalization mode is performed using dialogue and collective reflection. Hereby, a limited number of members of the organization elaborate on the knowledge and ideas which have been shared with them in the first phase. In a business environment, this is normally done by small workgroups and teams or task forces. In this phase, explicit knowledge is created in form of new plans or concepts.

To be covered by the whole organization, the new developed idea or concept (knowledge) has to be considered by the whole organization and must therefore been transferred from the small group which came up with this new knowledge. For this transfer, inter organizational networks are used. If the organization rejects the new development, the process ends at this point. In case the organization finds the idea worthy of further commitment, it can be further pursued in the next phase. This consideration of new knowledge by the whole organization reflects the modus of combination.

The fourth phase starts if the organization agrees upon new developments and it is proceeded with the building of an actual and official implementation of this new knowledge. This manifestation can be in form of “soft” innovations like new corporate rules, new software or proceedings. But it is also possible to incorporate the new achieved knowledge in “hard” product development in form of models, prototypes or actual products. Based on this explicit expression of the knowledge, others can get the idea behind it without special explanation which roughly corresponds to the internalization mode. Through “learning by doing” the new knowledge becomes available not only to the organization but also to customers and all other individuals who come in contact with the product.

During this process, which until now is merely a linear progression and development of one trail of thought, the nature and form of the knowledge handled is altered from “sympathized knowledge over conceptual knowledge to systemic knowledge” (Nonaka, 2001). At the end of the fourth phase, the product can be considered "operational knowledge". These four modes of conversion create a circle, when the final knowledge is run through this process again or changes have to be made through the introduction of new ideas. Anyway, over time as a 3rd dimension and weather the same knowledge is processed or a new knowledge is created from a different set of thoughts, the circle expands to a spiral in this 3rd dimension.

Anyhow, this process is based on a series of assumptions which must be dealt with in order to stop a failure of the process. Especially from a cognitive point of view like Harrison (Harrison, 2000) discusses, phase three of the process is very endangered for failure. Nonaka discusses a possible refining, approval or disapproval by the organization in case new knowledge emerges. Harrison elaborates on this process in depth and also proposes the possibility of information and knowledge hoarding by
members of groups within the organization which would hinder or stop this process. It seems also possible that newly created knowledge is been accepted without the necessary assessment and therefore can lead to critical outcomes. These thoughts again lead to the need for more control of this process which on the other hand is neglected by Nonaka as the upcoming paragraph clarifies.

According to Nonaka (Nonaka, 1994), the driving force behind the spiral is the intention of the organization to achieve its goals. Again Nonaka points out, that a successful knowledge creation based on this process requires the employees’ commitment which must reflect the intentions of the company and must also be supported by it. To facilitate the process further, the organization must grant autonomy to their employees. Hereby Nonaka expects the chances of unexpected opportunities to increase. In the use of self-organizing teams he sees the best way to enable cross-function in the organization.

As a third enforcer of the spiral Nonaka calls for more “fluctuation and creative chaos” in companies. Since new ideas and knowledge emerge from socialization with others, higher communication and involvement of other areas of the same organization and the surrounding environment can only lead to a better basis for innovation.

The fourth important point is redundancy which has been already pointed out earlier. Although it is often regarded to be not efficient, the overlap of information can trigger sharing by “learning by intrusion” (Nonaka, 1994). This can also been achieved not only by an overlap of information but also by an overlap of functionality, which is why Nonaka here favors job rotation as a means for creating innovative potential.

As a last facilitating measure, Nonaka finds that an organizations structure should match the one of its environment to be able to understand all the possible problems and to be able to deal with them.

In addition to these enablers, Harrison (Harrison, 2000) calls for a climate of openness, support and trust which should be completed by business processes and structures tailored specifically for the support of a free sharing culture in an organization.

Additionally to the above, Nonaka et. al. (Nonaka, 2001) also state that this creative process only works properly if it is supported by an enabling context, which they describe with the Japanese word ba “a context that harbors meaning”, describing not only a physical space but also space at a specific time including personal relations. Corresponding to the four modes of knowledge creation, four different ba’s are introduced, each representing the platform for the creation of knowledge following a specific mode. They are:

- originating ba
- interacting ba
- cyber ba
- exercising ba
Originating ba is the surrounding for the socialization mode where the organizational knowledge creation process starts. It represents a common place where individuals meet at the same time and can share experiences on a face-to-face basis. Interacting ba facilitates the externalization mode and represents a place where knowledge is shared between individuals by the means of collaboration in action and dialoguing. Cyber ba means the virtual area which supports interaction and is therefore supposed to raise the efficiency of the combination mode. Exercising ba is the ground for the internalization mode and means a space where individuals learn through action.

Huber (Huber, 1991) requires knowledge management efforts to be a single holistic, integrated process of organizational learning: it incorporates knowledge creation and acquisition, the interpretation, transformation and distribution of knowledge and the retention of new knowledge in the organizational memory. Nonaka et. al. (Nonaka, 2001a) agree with this needs expressed by Huber and continue to mark the fields of knowledge management which have not been fully supported by information technology yet. They state that although there is a number of software tool that support knowledge handling, but that there is no integrated and holistic program which deals with explicit and tacit knowledge at the same time and that there is also no integrated technological support for knowledge creation as demanded by Huber. Nonaka et. al. consider the Information technology which is used today in knowledge management efforts to be only information handling systems which are unable to adapt to changes which occur constantly due to the social nature of knowledge and an unlimited number of different outcomes during knowledge work. According to Nonaka et. al. this lack of support for knowledge creation as a dynamic process is a logical consequence of information technology being still of a deterministic nature. Nonaka et. al. criticize that until now, only the combination mode of their “spiral of knowledge creation” is supported by Computer programs which “rely on algorithmically accumulated data to select new explicit knowledge that fits patterns”. For a complete support of knowledge creation they argue that all four modes of knowledge creation have to be facilitated by information technology. As stated before, Nonaka et. al. believe that knowledge only emerges from a physical context. Therefore they conclude that the four ba’s, explained before, must be build and sustained by information technology as platforms, a virtual context for knowledge work. The following table summarizes the possibilities provided by information technology to support the different modes. Nonaka et. al. feel that most of these possible aids have not been fully exploited yet, except for those facilitating the combination mode.
| Socialization | Originating ba | - multimedia communication  
|               |               | - yellow page systems which  
|               |               | facilitate access to knowledge  
|               |               | resources                   |
| Externalization | Dialoguing/interacting ba | - virtual places for dialogue (more  
|               |               | virtuality than used today!)  
|               |               | - groupware like whiteboards,  
|               |               | virtual conferences          
|               |               | - examples: TeamFocus (IBM)   
|               |               | DEFACTO (DENTSU)             |
| Combination | Cyber/systemizing ba | - knowledge bases  
|             |                | - archives                  
|             |                | - should focus on human computer  
|             |                | interaction, not on automation! |
| Internalization | Exercising ba | - online manuals  
|                |                 | - FAQ’s                    
|                |                 | - networks                 
|                |                 | - expert systems           
|                |                 | - focus on asynchronous learning  
|                |                 | and remote communication    |

To complete the spiral of knowledge creation, Nonaka et. al. (Nonaka, 2001a) propose to not only use software tools to facilitate the four interacting modes of knowledge creation but also programs which trigger the shift between the modes and hereby create the spiral movement. By automatically enforcing a rhythm which forces the user to act and not to reflect, a stagnation of the process is prevented from happening. This can for example be achieved by the institution of a weekly news report which automatically creates the need for new ideas. Nonaka et. al. provide two case studies which prove the success of this concept of programs as an engine for the shifting of knowledge creation modes. In fact, the programs constitute the interface between the analog human factor and the digital information technology. For a continually shift, Nonaka et. al. propose to reinforce the organizational culture for this purpose and to schedule these shifts regularly. Again the authors recognize that the implementation of such a process is not a problem of technology which is available and must only be adjusted and tailored, but a special task for management which affords continuous supervision.

Alavi and Leidner (Alavi, 2001) identified a number of common information systems to support the knowledge creation process according to Nonaka. They find that data warehousing, data mining, document repositories and software search engines give great support for cyber ba. Interacting ba on the other hand is being supported by group support systems and electronic mail systems. The internalization mode or learning-by-doing can be supported by smart tutoring software and computer simulations.
<table>
<thead>
<tr>
<th>Creative space</th>
<th>Information technology support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyber ba</td>
<td>Data warehousing, data mining, document repositories, software search engines</td>
</tr>
<tr>
<td>Interacting ba</td>
<td>Group support software, electronic mail</td>
</tr>
<tr>
<td>Exercising ba</td>
<td>Smart tutoring software, computer simulations</td>
</tr>
</tbody>
</table>

Summarizing the various, more or less detailed, views of organizational knowledge or learning from above, there are three different possibilities, which have also been identified amongst others by Kuutti at. al. (Kuutti, 2000):

- Learning as a refinement of routines: This concept is also known as learning by doing and trial and error. During these processes, the achieved knowledge is embedded into routines and commonly analyzed by the measurement of efficiency.

- Learning through communities of practice: These communities, which exist and evolve inside or often also across the borders of an organization seek the best solution for a process and gain new insights and learn during this process.

- Organizational learning can also be seen as knowledge processing: Most famous research in this social process has been conducted by Nonaka and Takeuchi (1995)(cycle of knowledge production).

### 3.3.2 Knowledge from an economic point of view

In an economic context one must think again different of knowledge than of the one which is held by a single person and was acquired through learning. Not only persons but also whole social systems of different size and structure can be carriers of knowledge in an organization. Also the company itself can be a knowledge carrying entity. With the advance in technology, it are those knowledge-based networks that constitute the real asset of enterprises these days. Knowledge therefore gained a lot of value in the enterprise and is more than equal to traditional assets like real estate or working stock. Unfortunately, Götz et al. (Götz, 2004) claim, that only 20 to 40 per cent of the knowledge that exists in an enterprise is actually being used. They say that the employees are now required to develop their skills to think in a network and doing so take also better use of the existing technological networks. This sharing of knowledge inside of the enterprise and also the transfer of knowledge with the outside will regulate itself and follow the rules of a normal market. This means, that the market value of different knowledge can then be determined by supply and demand. This type of highly sensitive knowledge is the basis for competitive advantages. Another type of knowledge
possesses more of a strategic value than market value. This is mostly dependant on whether the organization can use this knowledge for competitive advances or not. In this context, it is also important if another organization can use this knowledge eventually for their advantage.

Basically, Götz et al. conclude, that stand-alone-knowledge is practically worthless. Like during Mergers & Acquisitions one has to think about synergy effects and other advantages, new knowledge would create.

Companies dispose over a huge knowledge basis. But only knowledge that is available to the sub entities of the enterprise (people or knowledge processing machinery) can influence the decisions or actions of the enterprise. Today’s enterprises are actually a virtual entity of humans and machinery in which the knowledge is divided onto different knowledge carriers. As a consequence, the appropriate knowledge is not always there in the system, where it would be needed for action. A company viewed as an action entity has some system flaws. For example, the knowledge basis of the company is divided onto different carriers whose single knowledge is not consistent. The even bigger problem is that this division of the knowledge is not congruent to the “action system”, meaning, that not every entity that needs existing knowledge has direct access to it. The alignment of all entities belonging to a corporation to an integrated consistent behavior is job of the corporate management. Therefore the overall knowledge management in an enterprise is also the responsibility of the management. This is a rather complex task, since knowledge exists in a lot of different ways in the company. Depending on the way how knowledge is represented, different problems dealing with it can arise. Franken (Franken, 2002) presents four ways knowledge can be found in an enterprise:

1. **structured knowledge**: means formal knowledge which is predefined by meta knowledge for its use. This structured knowledge is an explicit part of the knowledge. Examples are: databases, card systems, financial or client accounts or completed standard forms. The formalized meta knowledge enables the purposive evaluation of the structured knowledge using predefined criteria.

2. **unstructured, formalized knowledge**: is not premarked by meta knowledge. This can be all kinds of documents, CAD data, pictures, etc. For humans using this unstructured knowledge, it is sometimes easy to assign structures to this knowledge because of their context knowledge they have. This can be based on the human intelligence because one recognizes a document as a bill and can identify the recipient and amount of money. But it can also be simply because the person has taken part in the corresponding project and is therefore familiar with the document.

3. **personal knowledge**: is connected to individuals. This kind of knowledge is neither recognizable nor accessible for other individuals. It can only be acquired via meta knowledge and is transferred by communication or demonstration and repetition.
4. collective knowledge: or: corporate knowledge; This can be cultural knowledge in that sense, that it is shared (understood and accepted) by every member of the organization. Or selected knowledge that is not available to all single entities but is matched onto the organization and guides the actions of the company. This can be institutionalized processes which are executed by the enterprise but are not formally captured.

Getting back to competition and the legitimization of the consulting business. As pointed out earlier, consultants are hired to provide expert knowledge to organizations which need this knowledge. They need to have a knowledge advantage before the client otherwise they would lack their authorization. But of all things it is the consulting service which diminishes this advantage because the knowledge is to some part transferred to the clients. It is therefore most important for the consulting industry to simultaneously create new knowledge that could be relevant to prospective customers. This knowledge to be created should have the greatest distance to common knowledge and be very rare so that other companies must depend on it and can not imitate it. To maintain a competitive advantage, a consulting company must focus on the development of own methods in their area of expertise.

This strategic knowledge creation, which results not as a solution to a problem but for the only purpose of knowledge as a competitive advantage is of course not restricted to consulting companies. In any business area, organizations may develop knowledge, concepts and ideas so to say, in advance to be better prepared for the future.

The ongoing discussion about knowledge leads some authors to think of the current era as the Knowledge age and consequently the corresponding businesses are referred to as the K-economy (Mithani, 2001). This name is based on the new manmade productive resource, the intellectual capital of companies, their knowledge. Mithani states that in the K-economy, competitive advantage is been achieved through the innovation and creation of knowledge. The author also recognizes that it is a great challenge for the managers to analyze and quantify these innovations and adjust the efforts in knowledge management to the business incomes. Since it is the “knowledge-worker” who owns the critical tools of competitiveness, they should get the best support possible for their work.

Liedtka (Liedtka, 1997) goes one step further in his evaluation of the K-economy. He incorporates the fact that the corporate environment is rapidly and constantly changing and continuous adaptation is therefore necessary to be able to sustain in competition. This constant change is grounded in the continuing reevaluation and evolution of knowledge which can only be pursued when knowledge workers learn constantly and collaborate with each other.
3.3.3 Special knowledge in consulting companies

It is generally known, that work in a consulting firm is very knowledge-intensive. Consultant skills and corporate philosophies can easily be learned by new employees and are also very similar among the companies. As Haun (Haun, 2002) states, the challenging factor here is to cultivate the transfer and management of the knowledge the company stands out for. At first one has to get an overview of the consultancy specific kinds of knowledge in order to be able to manage them properly. Haun identifies the following subjects of knowledge that are crucial to the success of a consulting company:

- Theory (system theory, cybernetic, chaos theory)
- Methodology of consulting (coaching, supervision, systemic intervention techniques)
- Forms, logic and operation of social organizations, their structures, conflict areas and possibilities for development
- Quality- and change management
- Teams, their guidance and development
- Project and conflict management
- Human resource development instruments
- Executive functions
- Communications
- Self management
- Diverse expert areas (marketing, controlling, etc)

A consulting company produces a lot of diverse knowledge from various different areas. Because of this, a well selected structure must not only reflect all the expert knowledge, represented above, but also the different departments or areas it will be reused later on. All the business processes like consulting, marketing, distribution, development or human resources must be supported by an overall knowledge management. Most companies already support some of their business objects with specialized systems, listed below. The knowledge of the types, listed above may vary depending on the expert area a company focuses on. The following business objects are almost equal to all consulting firms and vary only in specific data.

- **problem solutions**: For an effective and efficient project execution knowledge in a generalized and standardized form is needed. This can be provided by tools with varying generalization like: Questions and Answers, example cases, tool descriptions, reference solutions, methods or architecture models.
• **technologies, business sectors**: The new technologies give the biggest impulses in the consulting business. Basics, functions, possible uses and business potentials of these technologies can be provided in corresponding surveys, news and example cases.

• **projects**: In each single Project a great amount of very specific data is produced. It is impossible or at least to time and work consuming to extract methods or models by generalizing the output of the project. This is why project knowledge must be kept ready in form of contact persons, project documentation and lessons learned kind of documents.

• **clients**: Knowledge about the clients is stored to support the work of the marketing and sales divisions. But these specifics about customers are also very helpful for the consultants to produce more specific and therefore better project solutions.

• **employees, partners**: probably the most crucial area in a consulting company is the access of undocumented or not yet documented knowledge by the use of contact persons. To find the best suitable contact, it is necessary to store the capabilities and working experiences of the employees and make this information available to the whole company. In some companies this portal is also used to support the planning of new projects and find free appropriate resources for a job. Adding employee development wishes to the list, it can also be used to support human resource development.

• **competitors**: Facts about the strategies and actions of competitors enables a company to divine current trends. From this information they can extract suggestions about new products and services. This knowledge can also be used during the acquisition of new projects.

But different systems do not take into account that there are various connections between these business objects. The connection between employees and the project they work in, just to name one. Numerous analyses show that all these presented knowledge areas are divided into different points of view to facilitate the search function and navigation among them. The most common criteria identified by Haun (Haun, 2002) within consulting companies are:

- products and services
- business sectors
- processes
- project phases

59
Consulting companies are very knowledge intensive businesses and must therefore also master knowledge management. Their expertise in Knowledge management is one of the most valuable services a consulting company can sell to other companies (Bodendorf, 2002). But before knowledge management can be introduced to another organization, it must be ensured that members of this organization can exchange knowledge at first. Bodendorf et. al. identified lack of contact, relationships and common perspectives of members who don’t work aside to be the greatest barriers for knowledge exchange. Because of these problems, knowledge sharing and further possible barriers will be discussed coming up.

3.4 Knowledge sharing among humans in an organizational setting

The importance of knowledge in today’s business has been proved by a study conducted by Zhang (Zhang, 2004). The study recognizes the necessity to classify knowledge to be able to align strategies and technologies for the purpose of sharing different kinds of knowledge. Zhang describes knowledge in three dimensions:

- codifiability
- practice-embeddedness
- context-embeddedness

This system largely follows the schema of Nonaka seeing knowledge as either explicit or tacit being held by individuals or groups. Zhang concludes that it is simply the interaction between the different kinds of knowledge, the organizational needs and the technological possibilities which will determine a company’s success in knowledge sharing. But the conducted study also shows the limitations of information technology for facilitating the sharing of less codifiable knowledge and knowledge which is not explicit but embedded in practices and contexts.

As well as knowledge sharing seems to be the most important part in the knowledge process, it is also very hard to study for the following reasons, presented by Boer et. al. (Boer, 2002):

- it is difficult to define knowledge sharing therefore it is hard to look for
- no clear starting point or ending
- tacit nature of knowledge
- big amount of mental activity which can not be observed
Anyhow, knowledge sharing can occur within or between organizational settings like industries, organizations, business units, project teams, functional departments, communities or informal networks. After all, knowledge is a personalized quality and it must be communicated among humans so others can interpret the information and reflect upon it themselves to be useful (Hansen, 1999). Since the critical activities in this sharing and interpreting process take exclusively place among humans, I will focus on knowledge sharing among humans in the upcoming paragraphs.

As established before, knowing is a human activity. Knowledge involves our experience and can for that matter not be stored by anybody or anything else, like a computer. Lacking experiences, knowledge is reduced to information, which then again can be stored by computers. During the knowledge creation process, a human mind gathers information together, reflects on its experiences, generates insights and finally uses those new insights to solve problems. This thinking process transforms information into insights and commences to a practical appliance, the solving of problems. From this very personal point of view, McDermott (McDermott, 1999) concludes that also this knowledge creation process cannot be performed by a machine. He further explains that, since knowledge is dependant on the experience of a person, which is subject to constant change, knowledge is always a product of the present moment. Therefore it is a prerequisite for knowledge sharing to think about the present moment. According to McDermott we also take into account who needs the knowledge, for what purpose, and in what detail i.e. in case the receiver is a novice or expert. All these variables would overload a deterministic machine.

McDermott further continues to accredit knowledge also to be a property of communities. After birth knowledge is acquired and presented by parents and communities we are in. Based on this given knowledge, we build our thoughts on the thinking of others. This constitutes knowledge sharing. "We acquire knowledge by participating in a community, using the tools, ideas, techniques, and unwritten artifacts of that community; whereas we acquire information by reading, observing, or otherwise absorbing it" (McDermott, 1999). Saying so, McDermott clearly draws the line, where the capabilities of machines end and the responsibility of the human mind begins. He goes one step further and states that without the contact to other persons we would not have much reason to reflect on information. Discussing new ideas with other humans gives us new insights and lets us reflect on our own thoughts thereby incorporating other ideas in our own knowledge.

To conclude from the above, McDermott argues that by only increasing the amount of information, we address only one side of the problem. Since communities and interpersonal relations and communication are at least equally important to the knowledge creation process as the supply with information, we must not only enhance information but also the social thinking part of knowledge. This is partially a social but also a technical challenge. From a social perspective, it is necessary to make people share and communicate despite possible differences. This paper is of course concerned with the possibilities of technical enhancement of communication and the creation of communities, which is now proven to be necessary.
From a more pragmatic point of view, Boer et. al. (Boer, 2002) continue from having distinguished between explicit and implicit knowledge to identify possibilities of transferring these kinds of knowledge from person to person. They then consider knowledge sharing to occur in an organizational context involving bigger groups.

For the transfer of explicit knowledge they adopt the codification strategy of Hansen et. al. (Hansen, 1999) where the knowledge transfer is basically conceptualized as transferring knowledge objects. This process is supported by a series of technologies as presented by Wasko et. al. (Wasko, 2000). They consider knowledge repositories, data bases and intelligent search engines to be of use for this purpose.

Talking about implicit knowledge, Boer et. al. agree that only humans are capable of knowing and converting what they know into actions. It is human thinking which transforms information into knowledge and creates new knowledge. Considering implicit knowledge for sharing, Boer et. al. mean the "exchange of information in order to yield knowledge". This exchange can be facilitated by information technologies like e-mail, video-conferencing and knowledge maps.

**Sharing: what, how?**

As described in the chapter on the organizational knowledge process and the spiral of knowledge creation, the main part of the sharing activity is the dynamic interaction between members of the organization. Namely, these processes are now known as socialization and articulation. Articulation hereby means the process of externalization as understood by Nonaka (Nonaka 1992), which requires an active involvement of the self. Externalization means the transfer from one’s tacit knowledge to explicit knowledge which can then be understood and acquired by other individuals. In other words, the most critical part is the sharing of one’s knowledge. Very view authors present usable ideas to support exactly this process.

Nonaka (Nonaka, 1995, 1992) approaches this problem area from a cultural point of view. By comparing cases of western and eastern corporate success stories, the author finds one possibility of transferring implicit knowledge among humans. Nonaka found that western culture influenced leadership emphasizes on formal, systematic and codified procedures. He finds these concepts to be driven by the need to measure knowledge with the metrics of increased efficiency and lower cost. On the other hand he claims to have identified the centerpiece of the Japanese approach which highly depends on tapping the tacit and often highly subjective insights, intuitions and hunches of individual employees. These key factors all constitute tacit knowledge because they are not obvious but only reside inside a persons mind. Japanese managers encourage the “sharing” process first by linking contradictory things and ideas through metaphor. To achieve this distinctive method of perception figurative language is used. In metaphors, objects are substituted by other objects with known implicit and explicit features and relations, to clarify the meaning of the replaced object. Metaphor is a way of perceiving or intuitively understanding one thing by imaging another thing symbolically. This theory already incorporates findings of this paper I described earlier. On the biological level of memory processes, I described that information is more likely to be understood and stored for long time if it is perceived in more than one sensual way. By the use of
metaphor we do not only perceive letters and sentences but also a kind of mental image. The new idea we have in our mind then makes us automatically elaborate deeply on the meaning, since it a metaphor already proposes a possible link to another object which we have already in our mind. Of course it is of great importance here, that both exchanging parties share a common understanding of the used metaphorical object which is used to describe the desired object. Otherwise, this technique is rather a catalyst for creativity than one for a shared understanding. Anyways, this is a possible way to give a second person an idea of the context one has placed an information on his own. Despite a different context the receiver is in, she can intuitively understand the sender since the context is embedded in the metaphorical description of the information. In addition to the possibility of intuitive understanding, Nonaka also assigns this method the feature, that people can express more than what they would usually be able to state.

In a next step, the contradictory items linked by the metaphor are applied with an analogy which highlights the similarities of known concepts to a new idea. Nonaka regards analogy here to have the combined creative power of pure imagination and logical thinking.

Finally, the group which now has a more or less clear and shared understanding of the idea creates an actual model of the described object, embodying the very idea in its context. This way, the new concept including its context is available as a manifested object, constituting new knowledge, for everybody without the creative process Nonaka depicted here.

Nonaka here presents a possible way to create new knowledge from the desire to make an idea come true which seems contradictory to current frames of reference at first. To summarize the process: first contradictory ideas are linked by the use of metaphor; then these contradictions are resolved with the help of analogy; and finally the new created concept is embodied in a actual model, which makes the now “incorporated” knowledge available for the whole company. Since this method of knowledge creation is currently practiced only in eastern cooperations, Nonaka also places great importance on the cultural prerequisites for the successful execution of the method. According to the author (Nonaka, 1992) a redundant organization is inevitable for this process. “Redundancy Is important because it encourages frequent dialogue and communication.” Nonaka further finds that internal competition even amongst teams themselves encourages this knowledge creating process. Partial redundancy can be achieved by a strategic job rotation program which helps the employees to understand the business from a multiplicity of angles. The factor of redundancy is probably the most critical barrier for an application of this process in companies with western culture. According to Nonaka (Nonaka, 1995) the advantages for knowledge creation are still neglected in favour of cost efficiency. To use job rotation to facilitate the knowledge process is supported by the findings of Boland et. al. (Boland, 1995) who state that each community develops its own language, shared narratives and routines. Like the knowledge of one single human being, the knowledge of a community can only be understood in the context of this social system.

Over all, this method of creating and sharing knowledge promoted by Nonaka (Nonaka, 1995) is highly dependent on social factors as well as management and communication. Only at the end of the process, there is an actual artefact which can be captured and transferred or reproduced by a suited technology. The whole method basically relies on a few management principles which simply have to be enforced. This task does not
require any technological support. The main creative work is done in peoples’ minds and by transferring the outcomes of ones mental activity to other members of the organization. A possible and also important task for information systems is hereby to support the communication of these ideas among members of an organization. A facilitation of human mental activity must be discarded, since I established before that this process is purely human and can not be influenced by technology.

Sharing, why?

For every enterprise, which comprises of distributed operations the exchange of resources and therefore also the transfer of the intangible asset knowledge is inevitable for the own development. As stated before, knowledge grew to be the most important factor of competition today. This is why the internal controlled evolution of knowledge in an organization is the most important task.

Focusing on knowledge sharing in an organization, Ensign (Ensign, 2004) argues, that with the growing importance of knowledge for the company, knowledge also became the most important factor for the personal competitive position inside the enterprise (Harrison, 2000; Kuwada, 1998). Over all, employees are hired based on their skills and knowledge to be of value for the firm. The employee therefore has to protect her knowledge from her competitors just like the company protects its knowledge from other companies it is in competition with. To evaluate the reasons which cause members of an organization to share knowledge or not Ensign conducted a survey in conventional organizational setting with a common corporate culture.

If companies do not actively enforce a knowledge sharing culture, the decision weather to share or not is more or less based on normal social conventions. Having to decide, Ensign found that one considers the balance of past transactions and calculates the sum which can be positive, negative or zero. Based on this sum, we can feel obligated to share or that we are in somebody else’s debt. The strongest goal hereby showed to be to reduce the own indebtedness by sharing knowledge. Ensign further found that physical distance is a major barrier for the reception of knowledge. Summing up, it was also proven that it is most likely to receive knowledge from individuals with whom one had long personal relationships and who are indebted to oneself. Ensigns’ review of past studies in this field also underlines the important role of personal relations for the exchange of knowledge.

In addition Ensign also found a number of reasons which often cause members of an organization to withhold knowledge from other members: The reasons are:

- untrustworthy opponent
- opponent professionally inadequate
- opponent is said to be manipulative
- previous experience indicates political use of knowledge

As one can see, there is a vast number of problems which can hinder the sharing of knowledge in conventional social settings. To avoid these pitfalls, it seems necessary to tailor the corporate culture in a way that it does not induce these reasons which hinder
the free transfer of knowledge. Anyway, Information technology can only be of supporting function here, since the corporate culture is a matter of high management.

A possible solution to create such a supporting corporate culture is to establish knowledge as a common good in the enterprise so that everyone is supposed to have free access even if he has not yet contributed to this public good. Unfortunately, as Galletta (Galletta, 2002) states, with the idea of a free common good, there is automatically the problem of free riders, which eventually leads to the destruction of the free good due to undersupply with new input. Common approaches to facilitate sharing with Knowledge bases where knowledge is considered as a free common good involve managerial control, group identification, and social value orientation of the members of an organization. These managerial means are used to create a social environment which is supposed to support the sharing practice. Three types of personalities are distinguished: individualist, competitor, and collectivist. These social characters can either be of a proself or a prosocial nature which causes them either to withhold and consummate knowledge or to share knowledge. The sharing behavior is also believed to be influenced by the feeling of group identification. These promising ideas have been proven wrong by a study conducted by Galletta. He found that group identification has no influence on the sharing behavior and that sharing is only dependent on weather the individual is of a proself or prosocial nature. Unfortunately, the study also showed that only 12% of the participants had a prosocial personality which means that an overwhelming majority will not share at all. These findings make it clear, that it is a very difficult task to create a social culture which enforces knowledge sharing. This study also shows that it can not be the task of information systems to make individuals share their knowledge. Instead, Galletta calls for a proper sharing culture prior to the establishment of knowledge management systems. Of course, information technology can be applied to facilitate the sharing of knowledge once the will to share has been created.

The perspective of Activity Theory

With knowledge sharing and creating being collective tasks, the concept of Activity Theory as discussed by Guttormsen et. al (Guttormsen, 2000) and Boer et. al. (Boer, 2002) comes to mind because it is concerned with collective mediated behavior which is directed towards a joint outcome. Activity theory hereby uses activities as basic units of analysis as opposed to individual actions. The concept additionally suggests that not only the learning process is dependent on the environment, but that this learning activity also shapes the surroundings. As a consequence, mental activity can be used to create tangible models, which is consistent with Nonaka’s model of knowledge creation as it is used by companies in the eastern cultural circle.

Another fundamental idea in modern activity theory is that the development of thoughts and cognitive activity are based on social interaction and exchange in a physical environment. It is a question of activity theory scientists to determine weather the Nonaka’s concept of Ba as a virtual surrounding for knowledge creation can be regarded as a physical environment in this sense (Nonaka, 1995).

With activity theory emphasizing that organizational settings are a systemic environment by considering them as a network of activities, we must be aware of the different social, organizational and technical platforms, comprising these settings. But since these
different systems intermingle to form one integrated organization, it is not sensible to focus solely on one part, i.e. the technical side. Instead one must also take into account the dependencies between these organizational factors, since they have influences on each other and changes in one field will affect the whole system. This conclusion finds support in the work of Kuutti et. al. (Kuutti, 2000), who introduce activity systems on the basis of Activity Theory which are supposed to help analyzing organizational learning and to direct the process of collective learning. The Authors claim that Organizational learning should be seen as follows:

1. “Organizational learning is a multifaceted and multiphased phenomenon, a complex interplay between different elements of a system. It cannot be studied by reducing the scope to one or another element, but a minimal meaningful system as a whole should be taken as the unit of analysis and intervention.”

2. “Organizational learning is always local and situational: structures, practices, habits and ways of thinking in an organization are all shaped and produced in the historical development of that particular organization. Transformation from the current situation to a new one cannot be done without a historical perspective.”

Finally, Boer et. al. also discuss the possible facilitation of knowledge of communities, which they try to paraphrase as “the social practice of knowledge”. This view does not consider the individual to be the carrier of knowledge but knowledge to be a property of a higher level community. Boer et. al. consider the knowledge stock of a community to be hold by all the members, where every individual is responsible for a specific part of it. Because of this division, the different members are dependent on each other and need to communicate the different pieces of knowledge. This is the reason why social processes like storytelling and conversation are very critical factors in this concept. Therefore, the creation of a shared understanding by a community as a social process must be considered to be knowledge sharing.

Summing up the above, knowledge sharing among individuals is obviously a very social process which heavily relies on communication. Therefore information technology that supports communication should be applied to facilitate this process. This is why Wasko et. al. (Wasko, 2000) found discussion groups, chat rooms and white boards to be the best means of information technology to support the knowledge sharing within communities.

### 3.4.1 Sharing barriers

Zhang (Zhang, 2004) emphasizes the similarities between knowledge sharing and other collaborative systems and finds that the main issues and problems are much alike. Zhang identifies four crucial factors in this matter: trust, leadership, settings, and size
and variety of groups. According to Zhang, the formation of mutual trust and the leaders’ success in maximizing the sharing of knowledge in the group is directly dependent on the organizational settings in which the group is situated. These surroundings can cause serious problems for a sharing culture because members might withhold knowledge because own purposes like avoiding risks or the protection of oneself get more important. Zhang also states that sharing requires intense interaction between all participants and therefore gets radically ineffective the higher the number of members in a group raises.

Empirical findings of Gabriel Szulanski (Szulanski, 1993) suggest three major barriers for knowledge exchange in organizations:

1. ignorance, on both ends of transfer (employees don’t know that there was anybody at the other side of the company providing/requiring k)
2. absorptive capacity, of the recipient (no resources time/money or practical detail available for implementation)
3. lack of relationship between source an recipient of knowledge

These inhibiting factors are all social or matters of coordination and not related to the field of information technology. Szulanski also points out, that these are only the top three barriers and that there are of course more difficulties to overcome for a free exchange of knowledge.

Another, often underestimated problem is, i.e. the problem of unlearning, which occurs with the socialization of new members to an organization (Huber, 1991). New employees get quickly accommodated with common organizational routines and thinking patterns which causes them to “forget” conflicting knowledge. This way, the new knowledge becomes unavailable to the organization.

Constant et. al. (Constant, 1994) investigated the sharing behavior in organizational settings and discovered that “users do not want to share all types of knowledge”. The decision process weather to share or not is dependant on two major factors. They adopt the view of explicit and implicit knowledge and found that explicit knowledge is shared almost without boundaries, because this is a basic task which is laid down in corporate rules like work orders or process descriptions. Therefore everybody has to fulfill these tasks otherwise they would massively disturb the work process and so inhibit the parts of the company which are dependent on their participation from completing their workload properly. By such a behavior not sharing members of the cooperation would directly violate their job descriptions and for this reason also risk the termination of their employment.

Regarding the implicit part of knowledge, the sharing of this expertise is always subject to considerations of self interest. In our daily life outside of our workplace as well as in most companies, as they find, we expect a certain return for the action of sharing. The decisions to share and how much knowledge and in what quality we share is based on
the social value we believe a certain information has. The study showed that this value is dependant on the setting it is perceived in, organizational or personal. The cases show that the only working possibility to encourage the sharing of implicit knowledge regardless of this system of social values is to tailor this system in the organizational environment so that people feel obligated to share and not expect direct return for this action. A corporate identity which incorporates the organizational ownership of knowledge has been proven by the study to best encourage the sharing of knowledge.

Another set of problems with knowledge sharing, which are more of a social nature than a technical one, is discussed by Wasko et. al. (Wasko, 2000). The authors here conducted three surveys to prove their perspective on how knowledge should be treated in an organizational environment. They claim that the unwillingness of members of an organization to share knowledge with others is based on the common view of knowledge as a private good of either the organization or an individual. Their surveys support the idea of regarding knowledge as a public good. This is mainly because if knowledge is not longer considered to be owned by an individual, moral obligation and community interests supercede self-interest and cause the members to share.

Traditional views of knowledge tend to neglect the social features of knowledge. Davenport and Prusak (Davenport, 1998) see knowledge as an object that can be exchanged and manipulated like any other good and therefore exists independently from individuals and their experiences and action. Hansen et al. (Hansen, 1999) as discussed before see knowledge as embedded in individuals which also enlightens the idea of ownership. The authors found in their study that Knowledge management systems which were designed on basis of these views tend to hinder the sharing process because participants are protective of their knowledge and also expect returns for their sharing. In opposition to this, they find systems which are based on the idea of knowledge as a public good to facilitate the sharing because group members feel automatically obligated to participate in the creation of their public good.

KMS which facilitate the exchange of knowledge in this perspective of knowledge are "collaborative technologies such as chat facilities, electronic bulletin boards and electronic discussion groups".

KMS which provide best support for knowledge sharing from an individual knowledge perspective are: "online directories and knowledge maps which identify "who knows what", and email systems.

KMS which promote a view of knowledge as objects held by the organization include systems which facilitate the codification, storage and transfer of artifacts. This concept is usually realized by large knowledge-repositories containing databases which store texts, videos, audio material and graphics. Search engines and intelligent filters are used to find the desired knowledge in this deposit.
The motivation to share knowledge differs according to the perspective on knowledge, a company has and promotes among its employees. It is mainly a social construction by the corporate life and therefore the responsibility of management, if knowledge exchange is seen as an economic or non-economic process. Weather knowledge is viewed as an object or as a feature of an individual, it is always the private good of either the organization or a person. Wasko (Wasko, 2000) found that this fact always leads to the exchange of knowledge after the rules of the free market. People therefore will always expect either intangible or tangible returns for providing information. If knowledge is considered a public good, people tend to maximize their self interest and use the public good without contributing to it. But Wasko also cites several studies which suggest that depending on the corporate culture, members of an organization take their sense of fairness, their public duty, and the concern for their community into account and also share knowledge. Wasko also found evidence that promoting the sharing for a public good through reward systems undermines the interest in the main work and also destroys the quality of the public good.

The study conducted by Wasko indicates that participants of communities engage in their actions of receiving and helping others because they appreciate the community they are in and are able to consult. Members seem to be aware that the online dialog and debates contribute to their own knowledge creating process. The sharing process is most productive, if participants are members of the same community and share the same narratives and values. Otherwise, the well known “not-invented-here” syndrome hinders the acceptance of new ideas.

The findings of Wasko give the following implications for KMS: the focus should not lie on rewards or knowledge markets because the enhancement of self-interest has been proven to destroy the public good of knowledge. Information technology should be used to connect potential participants to open-membership electronic communities of practice. According to Wasko, it is the responsibility of the corporate culture to convince members of an organization to participate in these communities for moral reasons.

As described earlier, enormous amounts of tacit knowledge are embedded in the practices and daily routines of employees. Often, these persons are not even aware of their knowledge but their outstanding performance based on this practice. In an effort to transfer this knowledge to other members of the organization despite the fact that the knowledge could not be identified but has been located due to best practice, internal benchmarking was introduced to find the best practices in the company and then transfer this knowledge in a socialization manner like Nonaka (Nonaka, 1992, 1994) proposes. O’Dell et. al. (O’Dell, 1998) define benchmarking as “the process of identifying, understanding and adapting outstanding practices from others”. While one tries to understand and adopt practices from somebody else, transfer of knowledge takes place. During their research, O’Dell et. al. found a number of barriers within organizations which hinder the free transfer of knowledge or in this case best practices. This is especially critical, since O’Dell et. al. assign humans the natural desire to learn and share. The identified organizational barriers are of logistical, structural and of cultural nature:
- organizational structures promote “silos” behaviour (employees in different locations or divisions focus on maximizing their own accomplishment)

- cultural values are holding up personal technical expertise and knowledge creation over knowledge sharing (“not-invented-here” syndrome)

- lack of contact, relationships and common perspectives (O’Dell, 1998; Bodendorf, 2002) (necessity to build networks based on the knowledge of each others existence in the firm)

- over-reliance on transmitting explicit information (encourage dialogue and interactive problem solving)

- time for learning and sharing is not included in the job description (enormous time demands have to be built into the work processes)

O’Dell et. al. consider the use of benchmarking and transfer of best practice to be a powerful tool for knowledge transfer since this process automatically breaks established paradigms because the simultaneously deliver a new process and the prove that it works better. Based on a case study, O’Dell et. al. found that additionally to this compelling call to action and the demonstrated success of the practice, benchmarking also automates networks in the organization which are currently destroyed because of decentralization and downsizing actions. Benchmarking also sharpens the employees’ awareness for problems and competition. They have to recognize that somebody else does a job better and management is able to identify potential gains in processes. The case study of O’Dell et. al. also showed that despite the overcoming of the barriers listed above by implementing knowledge bases, access to information is not the dominant barrier to knowledge exchange. They found that personal networking is often neglected because the power of networking to transfer more complex information is not understood. The failure of knowledge bases is on the on side caused by lack of proper maintenance which is a fulltime job. Information is also very often not classified properly which makes it very hard to find the desired information. On the other side, organizational culture and personal behavior inhibit the sharing of knowledge because of wrong perceived value of information which is mostly generated by management activities.
O’Dell et. al. propose the following 7 keys to an effective knowledge transfer:

- Use benchmarking to create a sense of urgency or find a compelling reason to change

- Focus initial efforts on critical business issues that have rich payoff and are aligned with organizational values and strategy

- Make sure that every plane you allow to take off has a runway available for landing (no overexcitement, projects bound on resources)

- Change the reward system to encourage sharing and transfer (which is a people to people process!)

- Use technology as a catalyst to support networks and the internal search for best practices, but don’t rely on it as a solution.

- Leaders will need to consistently and constantly spread the message of sharing and leveraging K for the greater good

Again this solution for a better sharing of knowledge sees information technology only in a supporting role and placed higher importance on the creation of a supporting corporate culture which is a constant task for executive management.

Reviewing knowledge sharing from a more psychological point of view, Ackerman (Ackerman, 2003) identified three problem areas. First of all he states that because of the nature of tacit knowledge, experts are unable to articulate it. But there are also a number of cognitive and motivational barriers to knowledge sharing.

There is no problem with sharing explicit knowledge, since it can be expressed in detail using language and it can also be put in a context the same way. This way, recipients are able to perceive the expressed knowledge in its original meaning.

Ackerman summarizes the properties of tacit knowledge as they were discussed earlier in this paper. It is not easy to describe since it occurs at an unconscious level. Experts mostly are also unaware of their special skill and therefore have trouble articulating the specific information, novices need to learn the task. In Addition to being hard to codify, tacit knowledge is also attached to its environment which makes it difficult to generalize the knowledge for adoption of this solution in other areas. This problematic is related to the “not-invented-here syndrome”. Anyway, this leads Ackerman to the conclusion that tacit knowledge is more likely to be transferred if tasks are more similar to each other. The major problem within this area is, that experts forced to express their tacit knowledge perform worse within this task, since they have to describe a plan, they wouldn’t follow themselves because they have tacit knowledge about it.
From a cognitive perspective, Ackerman sees the greatest barrier for sharing tacit knowledge in the different mental representations experts and novices use. As described earlier in this paper, with increasing experience, the mental representation of this knowledge gets more abstract and simplified. High level expertise is here mentally represented by concepts and abstract representations. While experts solve problems by using these concepts, novices prefer a trial and error approach. Experts can fill in the gaps in their general models by use of their experience which novices of course don’t have. It is because of this difference in mental models that knowledge sharing from expert to beginner is so difficult since experts are not aware of the small steps novices need to perform and understand a task.

To overcome these cognitive barriers, which only affect experts and novices but not people with intermediate skills and knowledge Ackerman proposes to encourage two-way interaction between these two groups and additionally mediation through persons with intermediate knowledge. Ackerman also recognizes the power of prototyping to transfer tacit knowledge (also: Nonaka, 1994).

Ackerman also identified motivational limitations on knowledge sharing. As Ackerman points out, there is a natural competition between companies which can be also found on a team level within an organization. Even if this competition is not actively enforced by management, employees identify themselves with their team. The natural competition for promotions, salaries, bonuses, and profit sharing hinders knowledge sharing although these institutions are meant to encourage effort and diligence of the employee. Pfeffer (Pfeffer, 1999) goes one step further and accuses competition to turn co-workers into enemies. Put together, it is an unfortunate coincidence, that exactly those means which encourage effort and corporate identity and give the organization the possibility to control human behaviour also inhibit sharing of knowledge. Ackerman also recognizes that in such a social context, knowledge constitutes power, which nobody is willing to share voluntarily. Often applied rules to regulate this sharing behaviour are very often opposed by employees. Therefore he argues that as a consequence, it is inevitable to change the social environment to solve this dispute. Pfeffer agrees at this point and adds that learning, which involves sharing also involves failure. Therefore forgiveness is necessary to promote an aura where mistakes are not punished and learning therefore is encouraged.

Other than cognitive barriers, motivational problems are easier to resolve. Ackerman sees the obviously necessary changes in the organizational culture as the most urgent task. In addition he proposes to deemphasize status hierarchies, to reduce the competition between groups and to allow communities of practice to evolve freely.

Additionally to this internal competition, hierarchical structures are a second motivational barrier for knowledge sharing. Social constraints forbid to teach a higher level employee not at last because she is supposed to be more experienced anyway. As a result, the flow of information in an organization is hindered due to its hierarchical structure especially in the upward direction.

But according to Boer et. al. (Boer, 2002) it is not only these social constraints in hierarchical structures which hinder the sharing process, the organizational structures as a means of coordination influence the need for and ways in which knowledge is being shared. The division of labor practically divides the organization also in matters of communication. It is also comprehensible, that when a group has an official leader, the flow of information goes much more different, as when the group is autonomous. These
structures have also an effect on the knowledge sharing process in smaller organizational entities. Where members are sequentially dependant on each other, they transfer knowledge, equal members of a team on the other hand integrate knowledge. This way, organizational structure influences the creation of different types of knowledge.

Ackerman concludes also including a literature review that employees are more likely to share knowledge when they have a trusting relationship with their employing company. In order to encourage employees to share knowledge despite these barriers, Ackerman proposes to offer incentives for this additional effort in knowledge sharing. He also marks the importance of the additional time employees will need for sharing purposes. This time must be included in job descriptions and be planned by the company.

This recent research presented by Ackerman (Ackerman, 2003) lets us conclude that information technology is extremely useful but does not replace expertise or the learning, which takes place through interpersonal contact. For further advance in the field of knowledge management supported by information systems, the focus must lie on systems that facilitate the development of interpersonal connections around topics of interest.

Aside from these detailed social and technical barriers, Judge et. al. (Judge, 1997) present research findings which indicate, that the pure fact that humans organize themselves hinders the knowledge creation process, the bigger an organization gets. They conducted a study in R&D communities in biotech. Although the authors doubt that the findings can be generalized they should not be neglected because biotechnology itself is a highly innovative and knowledge intensive area and should therefore be of high interest. The findings indicate that large firms are less likely to create innovative thoughts than smaller entities, because of their need of hierarchy and bureaucracy and the corresponding regulations.

Judge et. al. found small personalized, autonomous communities which had all technological possibilities to be the most innovative.

Although Davenport and Prusak (Davenport, 1998) are aware of some of the social components involved in organizational knowledge management, they point out that little success has been achieved in finding ways to create corporate cultures which support the creation and sharing of knowledge. They also claim that no bigger company has managed until the year 1998 to swap their culture to a knowledge friendly climate. This claim is not at last supported by the findings from above which have identified knowledge supporting features to be contradictory to conventional, commonly applied settings. This failure of making changes despite the better knowledge should be subject to further research. Because of the proven critical importance of knowledge and a supporting culture it is necessary to identify further problems which seem to hinder the change process.

This investigation of the main barriers of knowledge sharing clearly placed information technology in a supporting role for the sharing process and additionally stated that information technology is not able to compensate for dilemmas in the social environment which is crucial for a successful sharing practice.
3.4.2 Narratives

From the discussion above we can summarize that for successful knowledge transfer and sharing, communication among the participants is absolutely necessary. Boland et al. as well as Wasko et al. agree that narratives are a very powerful means of communication because they produce a common mind set in a very simple way among the participants. Bolin et al. demonstrated the ability of narratives, myths and other types of stories to trigger change in a company by conducting an experimental study. As already described earlier there is a great fear among employees if changes in the enterprise are about to occur. This fear often hinders the emergence of new knowledge since new insights mostly lead to the replacement of old ones and therefore constitute a form of change. Bolin et. al. (Bolin, 2004) show that with the use of narratives, all included members can be incorporated in the change process and this way they become carriers of the change themselves.

During a case study at Fiat Auto Italy, Patriotta (Patriotta, 2003) verified a these features of narratives in an organizational context. Patriotta found narratives to be a fundamental medium for capturing the commonsensical, everyday character of organizational knowledge. They are also a means of sensemaking, because by being communicated, they represent a shared and widespread understanding of the organization. Narratives also reflect the semantic dimension of organizational knowledge and thereby demonstrate how meanings are selected, legitimized, encoded, and institutionalized within the organization. Because of this feature, narratives may also be used as a means to communicate or transfer ontologies, the descriptions of the environment, as one organization understands it to another organization, like Flensburg (Flensburg, 2004) proposes. Adopting the view of Patriotta, narratives are not only a way to achieve common understanding but they are also a representation of organizational knowledge. Hereby narratives provide one way of encoding and storing organizational knowledge which could not be achieved so far.

Going on, Patriotta describes narratives as “a form of problem-solving in our everyday coping with the world”. Additionally, narratives describe an individual’s behavior, her theories, and her accumulated wisdom. The telling of stories also facilitates the flow of knowledge within the organization. Not only are narratives a means to capture individual and corporate knowledge and are able to facilitate their flow in the organization, but narratives are also able to bridge between those theories and mind sets on the one side and the actual practical work on the other side. This again gives other members of the organization to identify with the knowledge even if they cannot handle the theoretical background. This way, narratives also incorporate experiences and can therefore be seen as a kind of organizational knowledge.

Davenport and Prusak (Davenport, 1998) as many others take into account the tacit and explicit nature of knowledge. They support the idea of narratives as a means of knowledge transfer within the organization. Narratives are the most powerful tool, we can use in social interaction to transfer our knowledge. This is why Davenport and Prusak also favor the personal contact instead of electronic ways of communication. Mentoring and apprenticeship are proposed as the best way of transfer. In this case and
also in group settings, thy consider narratives to be the only means to codify tacit knowledge.
Davenport and Prusak also cite several case studies which showed that even modern IT systems are still only capable to reflect rule based and unambiguous information. Intuition is simply a human quality and could not be transferred into a computer system yet.

Boland et. al. (Boland, 1995) expand the importance of narratives beyond the features explained above. They argue that there are two modes of human cognition: information processing mode and the narrative mode. They find good arguments and good stories to be equally important for understanding human cognition in an organizational knowledge context. Other than an argument, which is supposed to be logical, consistent and non contradictory, narratives should be interesting, plausible and believable. Boland et. al. state that arguments prove certain facts, narratives on the other hand explain how things or occurrences fit sensible in the context of the world as we share this understanding. “...the narrative mode of cognition provides access to the implicit assumptions and interpretive structures that characterize a community of knowing” (Boland, 1995).

Using multimedia which should include video and audio to enrich these narratives, Boland et. al. expect the benefits of learning by experience “to extend beyond normal constraints of space and time”.
The fact that narratives are always incomplete and that the reader has to fill in the gaps distinguishes them from usual learning as discussed before. This feature makes the receiver to reflect on the narrative himself and therefore to make it an experience for himself.

To enable the free telling of stories and the use of narratives, information technology without too many constraints on the input is necessary. Boland et. al. see groupware which facilitates the conduction of meetings, the construction of multi-author documents and the coordination of promises and deadlines of projects to be of best use in this case. As discussed a number of times before, this groupware must be of course an integrated set of different programs providing the features above. Boland et. al. call these different platforms which may be used for discussions on certain topics, forums. They argue that the different forums must be of free access for all participants which will use them according to their expertise. Additionally, the forums must not have any constraints at all, since the forum will be shaped through the use by the participants.
Considering the two cognitive modes presented above, the forums or programs are required to be of a high level of reflexivity as Boland et. al. state. Boland et. al. include their finding in the proposition of five new classes of forums:

- **Task Narrative Forums**
  (improves perspective making and taking in a community of knowing)

- **Knowledge Representation Forums**
  (documents which are hyperlinked with multimedia content and storyboards to
clarify the common understanding of the participating members)

- **Interpretive Reading Forums**
  (platform for new not yet incorporated input on which the members have to elaborate on first)

- **Theory Building Forums**
  (thought experiments, exploration on ideas)

- **Intelligent Agent and Expert System Forums**
  (integrated search in any kind of information source)

### 3.5 Need for Knowledge Management

Having realized the great economic power and importance, knowledge has today, it is absolutely necessary to be in complete control of this asset. Efforts to control and to strategically develop knowledge are generally known as knowledge management. As discussed before, especially consulting companies are extremely knowledge intensive business environments and therefore require an integrated and holistic approach to this subject. Hansen et. al. (Hansen, 1999) review a series of business histories of different consulting companies and conclude with a suggestion for a knowledge management approach for consultancies which can be tailored to the specific needs of each enterprise.

The case study Hansen et. al. conducted showed that the work and decisions consultants conduct are highly dependent on information acquired from a corporate knowledge base or from interpersonal networks among the consultants. Hansen et. al. point out that different companies here emphasize the focus on one of these information sources. It becomes quite clear, that not all consulting firms are highly dependent on tacit knowledge from personal networks. But then again, Hansen et. al. also state, that in order to prevent improper use of documents and other explicit knowledge from “non-personal” sources, some person to person contact is still necessary to be able to clarify the context of the information.

Basically Hansen et. al. were able to eliminate two different strategies which are generally pursued by consulting firms. At the one hand, there is the codification strategy where explicit knowledge is carefully codified and stored to easy use by anyone. This strategy requires heavy manpower and clear concepts on how and what knowledge should be extracted and codified. On the other hand there is the personalization strategy which makes use of information technology to facilitate the communication of knowledge among consultants but not the actual storage of knowledge.

Put together, Hansen et. al. verify the practical application of the findings so far in this thesis. The storage of knowledge by information systems is limited to explicit knowledge...
and when it comes to share tacit knowledge and distribute it in the organization, the only way to facilitate this process is to enable communication among the primary holders of knowledge, the consultants.

As mentioned before, the use of either one of these strategies is dependent on the business activities of the consulting company. Hansen et. Al. differentiate between It-consulting firms which are generally concerned with the implementation of computer programs and strategy consulting firms which focus on the invention of new concepts and ideas. It consultants implement known concepts of programming to solve specific problems. This is why they have a great need for a knowledge base where solutions to known problems can be found easily. Therefore, these types of companies prefer the codification strategy for the handling of organizational knowledge. Strategy consultants are usually very experienced knowledge workers who are hired to create new concepts and strategies based on their background knowledge. Known from the discussion in earlier chapters, to create new knowledge and ideas in a field, it is inevitable that the participants communicate with each other and reflect together on the subject. This is why strategy consultants were found to prefer a personalization strategy. Where the codification strategy requires a lot of maintenance and time effort to process new information, the personalization strategy involves heavy investments in the people network to provide communication facilities and the social environment to enable this process.

Another result of the study performed by Hansen et. al. is that none of these strategies can be followed exclusively or that they can not be followed to the same extent. Practical experience proposes a 80 to 20 approach where the strategy that supports the business purpose best should be pursued mainly and the other strategy in a supporting role. A proceeding study by Scheepers et. al. (Scheepers, 2004) could verify the successful application of the 80 to 20 approach only for the earlier stages of a company’s knowledge management. In advanced stages, they found the relation between the two strategies to have evolved to a 60 to 40 mixture, which of course is always dependent on the environmental circumstances, the corresponding enterprise is situated.

Hansen et. al. conclude that consulting firms have understood that most knowledge, especially tacit knowledge is not separable from its human carrier or actor, which lead to the development and application of the personalization strategy. The study finally showed that all knowledge management approaches were never pursued isolated from other central corporate activities. It was recognized that knowledge management benefits were highest, when knowledge management was combined with human resource efforts, information technology use, and the overall corporate strategy were aligned in an integrated process.

### 3.6 Knowledge Management Systems - KMS

As described earlier, it is a characteristic of consulting firms that their employees are distributed geographically and that they often have a lot of employees. Of course this is commonly true for almost every company today. Because of these high numbers of distributed entities, modern information and communication technology is a necessity for every modern firm. And this is not only under the point of view of knowledge management but also necessary for other business events. Quasi automatically,
collections of documents are created, even without knowledge management. Then it is probably made possible to search these depositories using key words for to find something like lessons learned or conclusions. At some point, a subdivision of the conglomerate of information into subject areas or different purposes seems inevitable. Another commonly used storage of data is a personnel database. Here all employees are listed with their field of expertise, their contacts and business areas. This way, everybody can find quickly somebody in the enterprise to consult in a specific problem situation. Some modern systems also combine the features for a system supported search and configuration of new project staff. Some companies also provide a possibility for online discussions mostly based on web technology. Weather it is the consulting business or any other business area, most companies started within the last decades to in a more or less conscious effort to get a hold of their knowledge and make use of it. With the ongoing research around knowledge work and the ever growing importance of knowledge for competition, companies are forced to invest more and more resources in the handling of knowledge. Because the development and maintenance of information systems can be very pricy, naturally, organizations go for a minimal but integrated application of all kinds of knowledge management systems, which can have various names and features: expert systems, decision support systems, executive information systems, organizational communication systems, organizational knowledge repositories, or collaborative tools.

Having this development in mind, it seems sensible at this point to remind of the difference between information and knowledge. From a knowledge point of view, huge collections of information must be considered useless unless they are actively processed by a human mind and are reflected upon. Otherwise the information does not become knowledge and is also not incorporated in the actions of the members of an organization.

In the following, I will attempt to categorize different technologies and list the features of different systems. From the discussion of the organizational knowledge process and the possible IT support of knowledge sharing, it is quite clear, that none of the available Information systems is qualified to provide a holistic solution itself. Therefore it is of great importance to be sure of the capabilities of the different technologies to be able to integrate them to a holistic knowledge management system as described above.

Alavi and Leidner (Alavi, 1999) defines Knowledge management systems as "information systems which are specifically designed to facilitate the codification, collection, integration, and dissemination of organizational knowledge".

In an attempt to categorize technologies, Alavi and Leidner (Alavi, 2001) identified three classes of knowledge management systems which are currently used in an organizational knowledge environment:

- applications which enable the coding and sharing of best practices
- applications which facilitate the creation of corporate knowledge directories
- applications which promote the creation of knowledge networks

For this last category of information and communication technologies Boer et. al. (2002) additionally distinguish between knowledge management systems which support either
synchronous or asynchronous communication. This distinction is of importance in case a company has distributed entities all over the globe which means that business is conducted in different time zones. This of course makes synchronous communication impossible.

A more detailed classification of the different programs is provided by Klosa (Klosa, 2001). In accordance with the knowledge model of Nonaka (Nonaka, 1995) he lists the different features, the four knowledge phases require of a supporting system. He also gives examples of such systems:

<table>
<thead>
<tr>
<th>Phase</th>
<th>Required support</th>
<th>Technology</th>
</tr>
</thead>
</table>
| Socialization | - informal communication, online discussion  
|             | - asking of questions  
|             | - retrieval of information                                                       | - email  
|             |                                                                             | - discussion boards  
|             |                                                                             | - white board  
|             |                                                                             | - hypermedia collaboration  
|             |                                                                             | - multimedia conferencing  
|             |                                                                             | - brainstorming systems  |
| Internalization | - Search for methods or lessons learned  
|             | - Process documentation  
|             | - Knowledge sharing  
|             | - Interpreted knowledge                                                        | - lessons learned database  
|             |                                                                             | - information system  
|             |                                                                             | - Data Warehouse  
|             |                                                                             | - Data Mining  |
| Externalization | - representation of concepts  
|             | - categorization and presentation of implicit knowledge  
|             | - personalized tools                                                            | - semantic networks  
|             |                                                                             | - knowledge ontologies  
|             |                                                                             | - network publishing  
|             |                                                                             | - push technologies  
|             |                                                                             | - agent technologies  
|             |                                                                             | - subject oriented support systems  
|             |                                                                             | - data warehouse  |
| Combination  | - knowledge sharing  
|             | - decision coordination                                                         | - computer supported communication  
|             |                                                                             | - search- and filter systems  
|             |                                                                             | - document management systems  
|             |                                                                             | - workflow management systems  
|             |                                                                             | - group decision support systems  |

Figure IV Classification: knowledge purpose - information technology
As one can easily see, some tools are of use for multiple purposes. It may also be true
that in some situations, a company does not need full support for all these processes, in
which case it is not sensible to go directly after such classifications like this one. Of
course there are various other classifications available throughout the literature which
are all dependent on the view the corresponding author has of the knowledge process in
organizations. But finally, when building up a knowledge management tool suite for a
company, the model of the knowledge creation process is just the theoretical
background based on which the company must define requirements for the systems that
need to support the different processes. These requirements must then be compared
with the features of common knowledge management programs in order to select a
number of them to form an integrated system. Depending on the circumstances, there is
also the possibility to create a brand new system tailored after these requirements.

The two main areas in knowledge management, which are of course also the main
factors of the knowledge creation process, must be incorporated in any case in a
knowledge management support system. As discussed in the chapter on the
organizational knowledge process, these are the fields of knowledge retrieval and
communications among the participants.

Discussing the information technology support of knowledge retrieval, it must be
managed to store information over longer time and then be able to select and retrieve
desired information upon request.

For the storage of data or information data bases have long been used and developed.
But since today's organizations have to deal with ever growing amount and diversity of
data one usually speaks of a data warehouse in an organizational context. Bach et. al.
(Bach, 1999) define data warehouse as a concept of efficient supply and use of high
quantity data which is analyzed to support decision processes. The data basis of such a
system is the data of all corporate information systems which can be supplemented by
external sources. Data warehouses provide a standard interface which can be used by
reporting systems, management information systems, decision support systems, data
mining systems and business support systems to select corresponding data for a
specific purpose. Because of the different architectures and technologies that may be
used in companies, there is a variety of data warehouse systems available today.
Fortunately, the raise of the internet promoted the development of web based search
engines which are mostly platform and technology independent. These search engines
can be used also in intranets and can also access the corporate data warehouse. Many
of the features of internet search engines have been adopted and developed further for
organizational use. In addition to the usual crawling, indexing and ranking and search
functions, corporate search modules also provide personalized profiles for search
agents, format filters and gateways to enable the search in different data bases, in case
a data warehouse is not available, and possibilities to include the search engine in other
organizational applications.

Efforts to support the communication in the organizations are included in the popular
field of Computer Supported Cooperative Work (CSCW) which comprises efforts to
support cooperative processes by information technology and making them more
efficient by doing so (Klosa, 2001). Group Decision Support Systems, Workgroup
Computing, Workgroup Automation, Cooperative Computing and Computer Aided Team are often used synonyms for CSCW.

By using the term Groupware, one refers to the explicit soft- or hardware implementing the CSCW concept (Klosa, 2001). According to Gentsch (Gentsch, 1999) groupware is multi-user software which is used to transfer information among members of a group in a coordinated manner. Gentsch uses a popular method to illustrate the power of different groupware systems. The following table adopts this view and classifies different groupware systems according to their applicability concerning the users’ whereabouts and timeframe:

<table>
<thead>
<tr>
<th>Collaboration of Team members</th>
<th>Same time</th>
<th>Different time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same place</td>
<td><strong>Synchronous face-to-face or human-machine communication:</strong></td>
<td><strong>Asynchronous face-to-face or human-machine communication:</strong></td>
</tr>
<tr>
<td></td>
<td>- computer supported meeting</td>
<td>- schedule management</td>
</tr>
<tr>
<td></td>
<td>- group decision support system</td>
<td>- project management software</td>
</tr>
<tr>
<td></td>
<td>- presentation software</td>
<td>- file sharing</td>
</tr>
<tr>
<td></td>
<td><strong>Asynchronous face-to-face or human-machine communication:</strong></td>
<td>- workflow systems</td>
</tr>
<tr>
<td>Different place</td>
<td><strong>Synchronous human-machine-human communication:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- audio and video conferences</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- screen sharing</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Asynchronous human-machine-human communication:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- email, voicemail, fax</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- electronic conferencing and bulletin boards</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- multi authoring systems</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- group memory</td>
<td></td>
</tr>
</tbody>
</table>

Altogether, these different systems make it possible to communicate with each other regardless of space and time. Summing up, groupware is best used for unstructured ad-hoc processes among participants. As Sheng-Cheng (Sheng-Cheng, 2002) notes, groupware is basically a coordination and communication medium. It is not suited to support knowledge sharing in task oriented processes, where face-to-face communication must be preferred.

The more sequential and defined processes get, another type of knowledge management system should be applied. Workflow Management Systems are used to coordinate complex workflows which are pursued cooperatively. Gehle et. al. (Gehle, 2001) state that sequential or parallel processes can be supported, planned and controlled by such systems. They also claim that efficiency of supported workflows has been proven to increase because of a more correct work and the quicker response times through use of electronic networks and media. But mostly, Workflow Management Systems are considered to be enablers of management goals like the description and monitoring of processes (workflows) or evaluation of the performance.
These two kinds of knowledge management systems each focus on one task. Therefore they are easy to pinpoint and can be integrated as a part of a whole. On the other hand, there exist also knowledge management suites on the market which provide more than one application area in knowledge management. Depending on the focus a system provides and on the requirements the existing system architecture in an organization poses, the best set of knowledge management tools can be selected to achieve an integrated and holistic system.

As mentioned earlier, knowledge changes due to new experiences and reflections over time. This causes a number of problems including that usual databases get quickly outdated and therefore also can contain false information. To avoid this problem and high maintenance cost that would be necessary to solve it, Haun (Haun, 2002) prefers an object oriented approach to make knowledge available. He argues that knowledge belongs to objects and their relations. Objects can be humans or documents. In order not to fix the objects knowledge, a graphical mapping of the object and its relations is preferred to be able to find the way to the object, which then can provide the correct information or knowledge at this point in time. Yellow Pages, Document Maps and Organizational Knowledge Maps are representative examples for such systems.

Following the question weather and how information technology, can support knowledge sharing and therefore knowledge management, Dingsøyr et. al. (Dingsøyr, 2003) conducted an empirical study evaluating the use of a knowledge repository in one consulting company. Although the number of objects studied is barely representative, it seems logically to assume consultants in other companies feel and behave the same way. The study was able to identify five typical usages of the company's knowledge repository:

- Solve a specific technical problem
- Getting an overview of problem areas
- Avoiding redundancy in having to explain the same solution to several people
- Improve individual work situation by adjusting technical tools
- Finding who has a specific competence in the company

Generally, knowledge repositories are used as a means to improve the daily business tasks. The questioned consultants expected it to make their lives easier by providing simple information in a comprehensible and fast manner. This is also why the consultants did not consider the single pieces of information they acquired through the system to be valuable and as a consequence of this did not feel obligated to share knowledge in return. Dingsøyr et. al. propose as a conclusion of their study and literature review that in the field of knowledge management systems, there now must follow a shift in the main focus.
of research and implementation. They feel that software engineers as well as knowledge officials must recognize and incorporate the, until now underestimated power of social aspects in knowledge work. Formal concepts, techniques and procedures of software engineering have been exhausted and are overemphasized according to the authors.

In addition to this insight, Mark Ackerman (Ackerman, 2003) focuses on the unpredictable way, social communities evolve. He argues that it can not be predicted which organization members eventually meet each other and sub sequentially have to exchange ideas to create new knowledge. These social bonds can occur also outside the organizational context and can therefore not be covered by a corporate concept.

The work of Péter Fehér (Fehér, 2003) informs us about another critical factor concerning the use of knowledge management systems. His concern is the problematic of knowledge termination which he understands as the activity of searching for invalid or irrelevant pieces of information in the knowledge management systems and deleting or archiving theses items. Hereby, deleting and archiving are supposed to be parallel processes, since deleting here means only the removal of the item from the active knowledge system. Archiving is inevitable because of the importance the concerning piece of information could have had for the organization in prior decision processes. Anyhow, this activity requires a constant and consequent involvement of a trained maintenance team, of course dependent on the size of the system. This process is necessary because computer systems which are used as Knowledge repositories are usually based on a database, which can be searched and is also indexed. All of these tasks performed on the system get less efficient with the increasing amount of data to be handled. Fehér cites experiences which suggest that common practice lets remain a knowledge item inside a knowledge management system, once it has been inserted. Unfortunately, these “bad” knowledge items which slow down the system also lead to a decreasing trust in the system because of the outdated information. In this development, Fehér sees the “death spiral of Knowledge Bases”.

![Figure IV Vicious circle of knowledge quality](image)
Starting with neglected maintenance, the quality of the data decreases and so diminishes the trust in the system. As a consequence the system is less used and following this, new investment in the system can not be justified. Because of this problem, Fehér argues that knowledge termination as a maintenance process must be repetitively and continuously performed to ensure the usability of the knowledge items. Of course one must be aware, that the result of easy to reach information is the costly deployment of domain experts who work exclusively on this task.

As already discussed earlier, sometimes, information technology is praised to be the best solution to successful knowledge management. This of course clearly conflicts with the discussion above, stating the problems with information technology. Concluding from their research, Brown and Duguid (Brown, 1991) state that knowledge does not at all circulate automatically in an organization because of information technology to facilitate this process has been made available. Additionally, studies of Vandenbosch et al. (Vandenbosch, 1997) suggest that the introduction of such systems has only random effect but the sharing of knowledge is still dependant on existing social bonds among the employees.

Of course, one could doubt the positive effects of heavy investments in knowledge management not at last because of the various reasons members of an organization could withhold knowledge anyway. Rich (Rich, 2001) expects instead a positive reinforcement of knowledge management efforts. They are aware of all the various factors that effect knowledge, especially in consultancies over time:

- organizational structure
- informal social processes
- interactions among people
- activities and incentives
- market changes
- personnel turnovers change knowledge

Rich et. al. understand organizational knowledge as the various types of knowledge the consultants can possess. It is the task of knowledge management to facilitate this knowledge stock in order to increase efficiency. Faster and better completed tasks are again expected to create greater revenues which, herby closing the loop, enable higher investments in knowledge management efforts.
This reinforcing feedback loop is dependent on the success of the investments in the knowledge management which should be concerned to cope with the problems listed above. Rich et. al. extend this loop with several others to a whole system which enables the knowledge management executive to calculate the necessity and effect of her actions.

According to Peter Gentsch (Gentsch, 1999) is the usability, the success, and the acceptance of a KM-System in crucially dependent on how user-friendly the relevant knowledge can be retrieved from the system and then be used. This is a rather logical conclusion, since it is obvious, that a system which is peevish and time consuming is probably unlikely to be used.

An other critical factor for success of a KM-system is the quality of the underlying knowledge. Here, quality means relevance to the current situation, validity and usability of the stored knowledge. If this quality is not insured, it diminishes the trust, the user put into the system and reduces the use and therefore the feeding and maintenance of knowledge. Which itself in the manner of a vicious circle leads to further reduction of the quality of the knowledge. In the worst case, this can continue until the complete disregarding of the KM-system.

Three major problems come along with common knowledge management systems which are in use today, as Markus (Markus, 2002) states. She argues that when general expert knowledge is made available for other users at a high level of abstraction, like in a information system, the knowledge then has to be contextualized when decisions have to be made in specific conditions. Although this activity is kind of a creative process, it is definitely a source for mistakes during the application of the expert knowledge which has been used primarily in a different context. As a second problem, Markus found that information systems generally are designed for a certain type of user. The fact that other types of users coming from other circumstances pose different requirements on the system which then are not fulfilled forbids or at least makes it difficult to let other users use the system, although cost efficiency may create the desire to do so. Finally, Markus discovered that users today have an overload of knowledge tools available but because
of historical developments, these programs are not integrated. They were introduced before the necessity for a holistic knowledge management approach was recognized and are therefore not included in the work process or with each other. Because of simplicity and reasons of comfort, users focus on a single tool they prefer but which does not cover the whole problem area.

A complementing study conducted by Vandenbosch et al. (Vandenbosch, 1997) showed that even best orchestrated implementations of groupware were not able to encourage the members of an organization to contact other people they did not know before and share knowledge with them. This is a problem which was also recognized by Davenport et. al. (Davenport, 1998). Vandenbosch et. al. were only able to record that already existing framework of members made use of the new medium and used the groupware to facilitate their social interaction and through this their exchange of knowledge. Vandenbosch et al. pinpoint the practical inability of IT systems to create new social contacts. They conclude that information systems can not be expected to build up new networks of sharing, but only to facilitate already existing social networks and the sharing among these members. The sharing process is therefore only speeded up by IT systems. The task of creating new social contacts and with that, additional sharing is according to the authors still a matter of exclusively human interaction at first.

From a practical perspective, Wasko et. al. (Wasko, 2000) as already discussed in the chapter on knowledge sharing, proposed a number of different technologies to be of use for the facilitation of the transfer of explicit, implicit and the knowledge of communities. Their findings are summarized in the following table:

<table>
<thead>
<tr>
<th>Explicit knowledge</th>
<th>Knowledge repositories</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Data bases</td>
</tr>
<tr>
<td></td>
<td>Intelligent search engines</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Implicit knowledge</th>
<th>e-mail</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>video-conferencing</td>
</tr>
<tr>
<td></td>
<td>knowledge-maps</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Knowledge of communities</th>
<th>Discussion groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>White boards</td>
</tr>
<tr>
<td></td>
<td>Chat rooms</td>
</tr>
</tbody>
</table>

Wasko et. al. point out, that the successful application of these tools is dependent on free and autonomous participation and use. They found reward systems and knowledge markets to be counterproductive. Therefore the focus here should lie on connecting willing participants in an open atmosphere.

Despite the main area of research for knowledge management being social sciences now, McGuinness et. al. (McGuinness, 2005) progressed with research and development in the field of information storing and handling. They propose the OWL Web Ontology Language, which is intended to be used when the information contained
in documents needs to be processed by applications, as opposed to situations where the content only needs to be presented to humans. OWL can be used, as it is the intention of an ontology, to explicitly represent the meaning of terms in vocabularies and the relationships between those terms. This development was already anticipated by Flensburg (Flensburg, 2004) who argued that with enough detail in an ontological description of information, this information would be machine readable. Although this technology seemingly has high potential to be of common use in the future, it must be left unconsidered in this discussion because of this uncertain state of development.
4 Conclusion

The discussion above showed that knowledge as a multidisciplinary property must also be handled in such a manner. Each perspective on knowledge of the different levels in individuals up to organizations made it clear that information technology already provides almost all the functionality needed. The main barriers for an exchange of knowledge seem to be simply the result of the nature of knowledge, especially the implicit part, and of constraints which are created through human social behaviour.

On the individual level, the methods and tools of e-learning have evolved to a satisfying level. Possible advances in this field require the areas of software engineering and human computer interaction to consider even more the social and psychological sciences. Unfortunately, literature here suggests that this subject area would require enormous work which in return would result in very little success considering the acquisition of knowledge.

On higher levels of knowledge sharing in groups or organizations, information technology support has to focus more on communication then on information supply, which is sufficiently supported at this point. The idea of supporting narratives which already contain context in addition to information and also induce automatic reflection in the receiver, seems very promising. Here information technology can be of use to facilitate the social ground of a common understanding between individuals, which is a prerequisite of knowledge transfer. This field requires further research.

Overall, Information systems provide all the functional features which are required for a successful knowledge management. Most authors indeed appreciate the diversity the different computer programs cover. It is agreed upon, that the matter knowledge management requires a holistic approach including the support through information technology. Several technological systems can be connected and integrated to a tailored system to meet the call for a holistic coverage.

Finally, it must be said that dealing with knowledge is at first and for most a social matter. This discussion showed that the biggest and most problems around the sharing of knowledge are based on human behaviour and our cultural surroundings. As the comparison of Japanese and western cultures showed, in order to improve knowledge sharing, radical changes in social structures are inevitable. This way, far reaching success can be achieved dealing with knowledge. On the other hand of course, human beings have always been afraid of change, what makes this a very difficult task and also requires a lot of further research to ensure a safe transition. Therefore, information technology is in a supporting role in this process, while the greatest emphasis lies on the social studies.
5 References


Abbas Zaheer et. al. (2004), A Semantic Grid-based E-Learning Framework (SELF)

Ackerman Mark S. (2003), Sharing Expertise Beyond Knowledge Management, The MIT Press, Cambridge, Massachusetts

Ackoff Russell (1996), On Learning and the Systems That Facilitate it, White Paper, Center for Quality of Management, Cambridge, MA


Antal Ariane Berthoin, et. al., Consultants as Agents of Organizational Learning: The Importance Of Marginality, in: Dierkes (2001)

Bach Volker, Vogler Petra, Österle Hubert (1999), Business Knowledge Management, Springer, Berlin


Bell J. (1993), Doing your research project - A guide for first-time researchers in education and social science, Open University Press, Buckingham

Bennett Thomas L. (1982), Introduction to physiological psychology, Wadsworth, Belmont CA


Boer Niels-Ingvar et al. (2002), An Activity Theory Approach for Studying the Situatedness of Knowledge Sharing, Proceedings of the 35th Hawaii International Conference on System Sciences

Boland Richard, Tenkasi Ramkrishnan (1995), Perspective Making and Perspective Taking in Communities of Knowing, Organization Science Vol. 6 No. 4, Institute for Operations Research and the Management Science

Boland Richard, Tenkasi Ramkrishnan, Te’eni Dov (1994), Designing Information Technology to Support Distributed Cognition, Organization Science Vol. 5 No. 3, The Institute of Management Sciences

Bolin Maria, Bergqvist Magnus, Ljungberg Jan (2004), A Narrative Mode of Change Management, in IRIS27, Falkenberg, Sweden

Brown John Seely, Duguid Paul (1991), Organizational Learning and Communities-of-Practice: Toward a Unified View of Working, Learning, and Innovation, Organization Science, Vol. 2 No. 1, Special Issue: Organizational Learning: Papers in Honor of (and by) James G. March


Crossan Mary et al. (1999), An Organizational Learning Framework: From Intuition To Institution, Academy of Management Review, Vol. 24, No. 3


Eklund John et. al. (2003), *e-learning: emerging issues and key trends*, www.flexiblelearning.net.au


Fehér P. (2003), *Knowledge Termination: The End of the Game?*, 25th Int. Conf. Information Technology Interfaces


Flensburg Per (2004), *Generation of ontologies for workflows*, in IRIS27, Falkenberg, Sweden


Galletta D. (2002), *What leads us to share valuable Knowledge?*, Proceedings of the 36th Hawaii International Conference on System Sciences


Götz Klaus (1999), *Wissensmanagement - Zwischen Wissen und Nichtwissen*, Rainer Hammel Verlag, München, Germany


Grant Robert, *Toward a knowledge-based theory of the firm*, Strategic management journal Vol. 17 Winter Special Issue, John Wiley & Sons, Ltd.

Gronau Norbert (2001), *Wissensmanagement*, Shaker Verlag, Aachen, Germany


Hergenhahn B. R., Olson Matthew (2001), *An Introduction to Theories of Learning*, Prentice Hall, New Jersey

Huber G. (1991), *Organizational Learning: To contributing processes and the literatures*, Institute of Management Sciences, Austin TX

Järvinen Pertti (1999), On Research Methods, Juvenes-Print, Tampere FIN


Kato Takashi (1996), *Implicit Aspects Of Human Learning and Memory*, IEEE International Workshop on Robot and Human Communication

Klosa Oliver (2001), *Wissensmanagementsysteme in Unternehmen*, Gabler, Wiesbaden


Lehner Franz (2000), *Organisational Memory*, Hanser, München, Germany


Maier Günter et. al., *Psychological Perspectives of Organizational Learning*, In: Dierkes (2001)


Mezirow Jack (1997), *Transformative Learning: Theory to Practice, New Directions for Adult And Continuing Education*, No. 74, Jossey-Bass Publishers


O'Dell C., Grayson J. (1998), *If Only We Know What We Know, California Management Review*, Vol. 40, No. 3

Patriotta Gerardo (2003), Sensemaking on the Shop Floor: Narratives of Knowledge in Organizations, Journal of Management Studies 40:2


Probst Gilbert, Raub Stefan, Romhardt Kai (1999), Wissen Managen, 2. Auflage, Gabler Wiesbaden


Rich E. (2001), Models for Understanding the Dynamics of Organizational Knowledge in Consulting Firms, Proceedings of the 34th Hawaii International Conference on System Sciences


Sheng-Cheng L. (2002), The reality of team-based Knowledge sharing and creation in professional Cyber Community, Proceedings of the 36th Hawaii International Conference on System Sciences

Smith Edward E. (2003), Atkinson & Hilgard's Introduction to Psychology, Thomson & Wadsworth, Belmont, CA, USA


Szulanski Gabriel (1993), Intra-firm transfer of best practice, appropriative capabilities and organizational barriers to appropriation, Academy of Management


Vick Rita, Johnson Apperson (2005), Prototyping the Emergence of Collaborative Knowledge, Proceedings of the 38th Hawaii International Conference on System Sciences


Willke H. (2001), Systemisches Wissensmanagement, Lucius & Lucius, Stuttgart

Zhang J. (2004), The Nature of Knowledge an Its Influence on Knowledge Sharing Practice, Proceedings of the 37th Hawaii International Conference on System Sciences