6 Conclusions & Outlook

Knowledge management strategies are based on technology, organisation and people. Traditional knowledge management tries to store the total enterprise knowledge into IT based containers. However, several problems prevent this. The most important issues in this context are:

- Phrasing and updates of knowledge are time consuming tasks.
- The willingness of the users to reveal their knowledge cannot be assumed.
- Knowledge is converted into information by the knowledge sharer and interpreted by the consumer. This can lead to misinterpretations because of the missing context.
- Technology based methods are unable to handle tacit knowledge.
- Integration of all used IT systems is a crucial task because of the missing semantic coherences of the provided information.

Therefore, storage and technologically oriented knowledge management is not an appropriate approach. The trend to communicate knowledge addresses this problem. This focuses on people's exchange of experience. Thereby, a common context implicitly has been set up. Misinterpretations can be avoided by an interactive communication process between the parties sharing knowledge.

Knowledge communication must be supported by identifying suitable persons for a certain topic of discussion. Then the communication process shall be supported by providing a communication infrastructure and by developing an organisational culture that allows enterprise wide knowledge exchange. Cultural factors that influence the exchange of knowledge are, e.g. company strategies, security policies, common insights of the company's key concepts.

This thesis approaches a hybrid solution consisting of an automated system and persons to support all knowledge management activities.

The hybrid concept consists of employees, experts and Knowledge Brokers (KB) using a special IT system. This system is a portal that supports the search for information and persons that are able to help solving a certain problem. When employees do not find the

appropriate information or expert, then they can ask a Knowledge Broker for assistance. To achieve this goal, Knowledge Brokers should cooperate. Thus, they form the Knowledge Broker Network (KBN). Every user addresses a personal Knowledge Broker as a default contact.

The KBN portal uses a knowledge network to model the key concepts of the company. The relationships between concepts and topics of expertise – represented by employees and experts – are mapped within the knowledge network.

“Meta-knowledge” describes only relationships between people and their experiences: the ability to answer questions in a certain field. Additionally, this type of information is located within a user profile. This user profile is maintained by the user himself, eventually with the assistance of his personal Knowledge Broker. Further topics of expertise can be added to the knowledge network and to the user profile by the user’s personal KB.

Areas of expertise tend to be outdated because of their dynamic behaviour (e.g. frequently changes). Therefore, documents and other information items that the user administrates within the knowledge network are analysed automatically with the aim to discover new experiences of that user to complete his / her profile.

Documents concerning the company’s demands will be stored using document management systems. These documents are created not only for knowledge management purposes, but also for reports or project documentations. The linking of these documents with nodes within the knowledge network is an additional task for creators or maintainers of documents. Important documents will be classified and linked manually to the knowledge network, e.g. documents for development of company strategies. Other documents can be analysed and classified automatically using information retrieval methods and other statistical models.

Periodically created documents can be represented by special nodes so that not every single report is linked with several nodes of the knowledge network. A node for marketing reports for instance is linked with a directory within a document management

system. As a search result the node itself and a list of all files of that directory are displayed. This is an example for the integration of IT systems into the KBN portal. The semantic coherence of the affected node is modelled within the knowledge network and the data is stored somewhere else.

To support the user's specific requirements the personalisation concept, included within the KBN approach, focuses on:

- user's personalised view into the knowledge network,
- private part of the knowledge network.

This means that not only the look and feel of the user interface provides a personalisation functionality, but also the information displayed is personalised. Therefore, rating and ranking of information items are used, e.g. items that are rated as "not of interest" by a certain user are hidden within his personalised view. Nodes within the user's private part of the knowledge network will be displayed only for him, but in an integrated view.

The support of communities is an important requirement of the KBN approach. When a community focuses on certain topics, it will be comparable with a "community of practice". A community of practice is a well-known approach discussed and used in the internet for over 17 years. The focus in this thesis is to identify topics of expertise for already existing communities of practice or for new ones. Knowledge Brokers with lots of experience in networking can support communities or create new communities.

Communities usually span the whole enterprise and break boundaries of organisational structures. In special cases, they cross company boundaries, e.g. by inclusion of consultants and partners.

Communities of practice support sharing of tacit knowledge when the communication is not limited to formalized means, e.g. email or forums. Therefore, physical meetings of communities should be strongly supported by the management and culture of the companies involved.

Another type of community – the network of people – can be discovered by analysing the communication behaviour within the KBN portal. These networks do not have to focus on a certain topic. Although they seem to be of lesser importance, such informal communities can motivate employees and groups to perform better.

The integration of web resources within the portal is an important requirement, which has been identified by potential users within a user's request. This can be done easily by querying an internet search machine and by adding the results to the result found by the internal KMS. This can lead to a serious problem: the quality of external resources cannot be guaranteed. Trust in external resources is influenced by several factors. It seems that there is no possibility for the development of a fully automated solution. This leads to the conclusion that users are motivated to give recommendations on web resources (e.g. documents, web pages, entire web sites). To support this, nodes within the knowledge network can be linked with URLs of external resources. By analysing the content of external resources, these can be classified automatically. This ensures the right classification of the resource within the knowledge network. Further, it discovers content changes of the external document.

Ontologies that are implemented using semantic web standards can be imported or integrated via their interfaces. Integration and import need to be done by people. They lead to the development of specialised connector modules, because – usually – the classification model of external resources differs from the internal knowledge structures.

Additionally, the management of bookmarks can be integrated within the KBN portal. These bookmarks are stored in the user's profile and a user can publish selected bookmarks within the portal. Published bookmarks can be used to provide additional hints to other users.

The thesis introduces a way to provide hints, additional to the standard search results of the KMS component of the KBN portal. An adaptable "Search Assistance Algorithm" (SAA) takes into account the user's search history and personalisation aspects.

Variations of the SAA can be adapted to the existing structures of the company's knowledge network. Search and retrieval technologies introduced in Chapter two can be used for the implementation of search functions. The strength of the SAA approach is its adaptability to the company's knowledge management system and knowledge structures. As a limitation of the approach, the development of a "out of the box" solution is not possible. Therefore, an infrastructure for the development and use of different SAA variants has been introduced in this thesis. The simplified SAA within this prototype can be used as a basis for further SAA implementations. This prototype is based on the functionality provided by K-Infinity that has been used as KMS.

Further applications of the man-machine-hybrid approach are possible. The thesis illustrates three examples: the IT assistance for SMEs, an infrastructure for personal assistants and a network of professional infobrokers.

A selection of prototypes illustrates:

- what a KBN portal can look like and how knowledge communication can be supported by such a portal,
- an infrastructure for the development of SAA variants and how new SAAs can be changed and work during runtime,
- how an Infobroker directory can be implemented.

The whole strategy introduced in the thesis focuses on the involvement of people to support company internal knowledge management. This leads to the main limitation of the approach: people, especially experts and knowledge brokers, cause more costs than technology! To calculate the return on investments of the adoption of the KBN approach to a company is difficult. It is recommended to start small, and to focus on organisational units, such as departments or locations. The experience, how the KBN approach fits to the company can then help to apply the KBN enterprise wide.

Additionally, this experience helps to decide how many knowledge brokers are needed for a certain organisational unit.

The focus on knowledge communication between people must be supported by the culture of the company. There are a lot of barriers introduced in the thesis that are not only specific to storage oriented knowledge management, but can disturb the communication flow as well. The willingness to share knowledge cannot be assumed for everybody. To motivate everybody to share his knowledge is an important task not only for the top management, but also for any member of the team.

A further limitation of this research is the use of a central system (see Section 4.7) for managing private information and linking them to the knowledge network of the company. This system is necessary for most of the automated processes and for the identification of experts. Therefore, employees have to trust the provider of the system. This leads also to an overall trust culture for all participating people and technologies.

As a result of applying the KBN approach and the development of the company culture teams will perform better and existing knowledge will be shared and used.

The new KBN approach uses technologies to support the communication and distribution of explicit and tacit knowledge. Analysing existing knowledge, potential topics for communities of practice can be discovered and KBs can guide the development and work of such a community. The realisation of personalisation concepts enhances the value of knowledge for employees. The user's problem solving process is supported by a Knowledge Broker solving problems and identifying and cooperating with experts.

Several aspects of the results achieved during this research activity have been published at various international conferences, journals and a book chapter with positive feedback from participants and reviewers (see Appendix A).

Résumé

Based on the hypothesis that knowledge cannot be managed [Kuhlen, 2004] because it is located in the mind of knowers [Davenport & Prusak, 1998] the main research question in this thesis was:

> **How we can make knowledge available for supporting people during their problem solving process?**

Therefore the KBN approach described in this thesis uses a mix of:

(a) providing collections of information;
(b) bringing people in contact with other people.

Every employee can choose between (a) and (b) depending on his personal preferences. Searching using the KBN portal, results of both types are available. The KBN personalisation concept allows every user to decide which type he prefers. Search results within the KBN portal are combinations of both types, but ranked using the user's preference.

Information items can be viewed and a communication with a person can be initiated within the portal. This seems to be the **shortest way to the knowledge desired**.

If a user is not successful with his own search, an Informationbroker offers him his assistance. This is also directly available within the KBN portal. The IB then provides the user with both types of results: collections of information and people (experts) to communicate with.

Additionally, based on a semantic oriented knowledge management system the meta-knowledge, "who knows what", is managed and can be discovered automatically. Retrieving information items stored in the KMS is only the first step in the KBN concept. If a user needs more information, he can contact an expert for the topic the information items are linked to. Thus the KBN concept enables the paradigm "Knowledge Management based on Communication" postulated by Kuhlen, 2004.

It also promotes team work (as postulated by LexisNexis & Forsa, 2004), even across company boundaries.

Supporting communities simplify the identification of an expert for a topic of a community. An employee can then ask the whole community and the KBN system, or an IB coordinates the request.

As described in Section 4.12 most people involved in the evaluation process agreed that the **KBN concept simplifies typical knowledge work**.

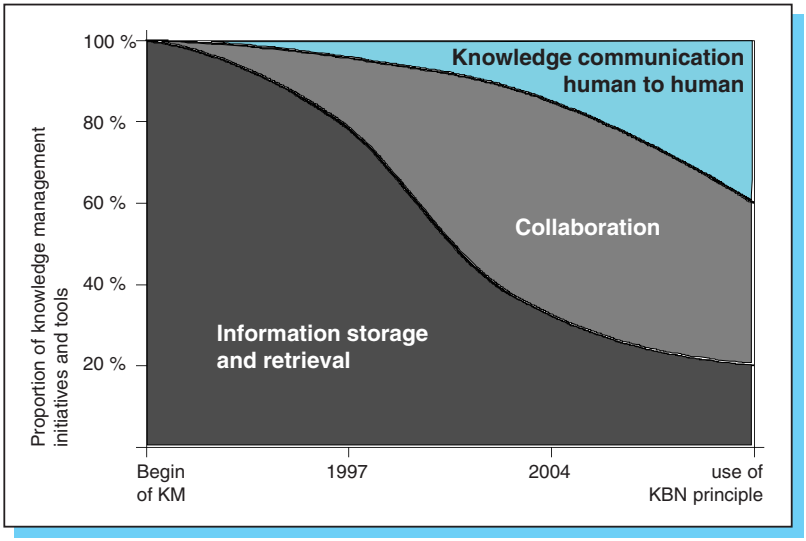

Figure 6-1 Trends changing from storage oriented KM to collaboration and communication oriented KM

As shown in Figure 6-1 knowledge management started as information storage and retrieval technology. Then the trend for the use of collaboration oriented tools arises as described in Section 3.1. Implementing the KBN concept knowledge management focuses on human to human communication supported by collaboration and storage oriented tools. Figure 6.1 shows on right hand side that approximately 40 % will be knowledge communication, 40 % collaboration and only 20 % information storage.

Limitations of the KBN Concept

As mentioned here, the KBN concept has the following main limitations:

- success is dependent on an open and communicative company culture;
- IT systems used are not on the market and must be developed individually.

The development of a company culture corresponding to the KBN concept is a difficult task that challenges all levels of the company management. What kind of incentive programs are able to support the employees' active cooperation depends on the character of the company and should be well-investigated as mentioned in d) in the following outlook section.

A knowledge management system on its own is not able to fulfil all aspects of the KBN concept yet. Therefore the "main" KMS should offer interfaces for integration with other systems. For instance the automated document analysis is offered by Knowledge Miner (see Section 2.3.2) and the results can be used by K-Infinity. As described in a) of the following outlook section the KMS used should also offer semantic web standards for integration and use of standard based ontologies. There is no KMS on the market that offers the full personalisation concept as described in Section 4.3 but the first steps can be seen (i.e. within K-Infinity). The approach for enhancing search results as described in the SAA section (4.5) also requires individual software development. This can be supported by providing a set of service functions as described in b) of the following outlook section.

Outlook

The following activities are proposed for further research:

a) integration of internal and external ontologies;
b) support the development of SAAs with search oriented service functions;
c) discover valuable information linked to user's recommended documents;
d) incentive activities to motivate employees to share their knowledge.

a) Semantic web standards can be used to implement ontologies. The availability of semantic web standards enables the use of combination of company internal knowledge structures with external ontologies. The use of common structures as the basis of internal and external ontologies, can enable the development of generic interfaces. The "Dublin Core" or similar approaches can be used as such a common structure. Trends in semantic web initiatives should be observed. It is important to know whether such existing common structures are used or whether new ones have been developed.

b) To support the development of company specific SAA variants, a library of service search functions can be useful. A set of generic functions must be independent from the functions of the KMS used. Therefore, they should be based on a standard, such as RDF/XML. Most KMSs are providing the export of RDF/XML data. The service functions can provide a set of search techniques for RDF/XML data. Reasoning and information retrieval methods can be helpful for the classification of unstructured information, such as documents. While the SAA shows additional hints, the performance is not a critical factor. It is possible to implement a system that is completely independent from the KMS and runs in the background. This system will be able to discover interesting information out of the exported RDF/XML data. Further it will use notification methods to inform the user about the results.

c) Another type of background process can be the analysis of links that are included within recommended internal and external documents (and web pages). Assuming that recommended documents are valuable, following links within these documents can lead to other interesting documents. Scientific papers can include literature lists referencing other interesting documents within the same topic.

d) Psychological oriented research will be of interest. Research should focus on incentive activities to motivate employees to share their knowledge. Especially, the motivation on improving the company's knowledge sharing culture in the context of a KBN is of interest. In literature incentive systems are evaluated with conflicting results. Some studies describe incentive initiatives as requirements for success [Reimer, 2002]. Other authors [Alony et al., 2007] argue that they are not important or that they are useless when the company culture does not support knowledge sharing activities.

To summarize: "A lot done, more to do".