Knowledge Networks – A Tools Perspective

Dipl.-Wirtsch. Inf. Jörg Raimann
Lic. Oec. HSG Marija Köhne
Dr. Andreas Seufert
Prof. Dr. Andrea Back
Prof. Dr. Georg von Krogh

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Research Center
KnowledgeSource
University of St. Gallen
http://www.KnowledgeSource.org

IWI-HSG
Institute for Informationmanagement
Prof. Dr. Andrea Back
Müller-Friedberg-Strasse 8
CH-9000 St. Gallen
Phone ++41 71 / 224-2545
Fax ++41 71 / 224-2716

IfB
Institute of Management
Prof. Dr. Georg von Krogh
Dufourstrasse 48
CH-9000 St. Gallen
Phone ++41 71 / 224-2356
Fax ++41 71 / 224-2355

Competence Center Knowledge Networks

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1 INTRODUCTION

1.1 Research Project Knowledge Networks

The Competence Center Knowledge Networks is a research project within the Research Center **KnowledgeSource**, a cooperation of the Institute of Management (Chair Prof. Dr. Georg von Krogh) and the Institute for Information Management (Chair Prof. Dr. Andrea Back) at the University of St. Gallen (HSG). Within the framework of an international research cooperation with business and research partners, KnowledgeSource seeks to develop an integrated approach to strategic and information management in order to achieve lasting competitive advantage through knowledge management.

The **Competence Center Knowledge Networks** (CC KNN) of KnowledgeSource was established 1998 in cooperation with the partner corporations DaimlerChrysler, Hewlett Packard, Lotus Professional Services, and Unilever. Research activities focus on an integrated view of knowledge management and networking. The main objectives of the Competence Center are to establish a shared understanding, a reference model, and a methodology of high performing knowledge networks. In this context, 'high performing' means that knowledge networks support specific business goals effectively and efficiently. These results aim at supporting our partner corporations in the process of establishing, recognizing, and facilitating knowledge networks within their organizations. To achieve this goal, the reference model and the methodology are based on academic research work, on bilateral projects with partner corporations, and on case studies of reputable organizations.

1.2 Initial Framework of Knowledge Networks

The initial framework of knowledge networks includes the following 4 components:

- *actors* – individuals, groups, organizations
- *relationships between actors*, which can be categorized by form, content and intensity;
- *resources* which may be used by actors to network with other individuals, groups or organizations
- *organizational properties*, including structural and cultural dimensions (such as control mechanisms), standard operating-procedures, norms and values, communication patterns, and others

These components can be perceived from either a static or a dynamic point of view. From a micro perspective, we conceptualize knowledge networks with the following three building-blocks (see figure 1):

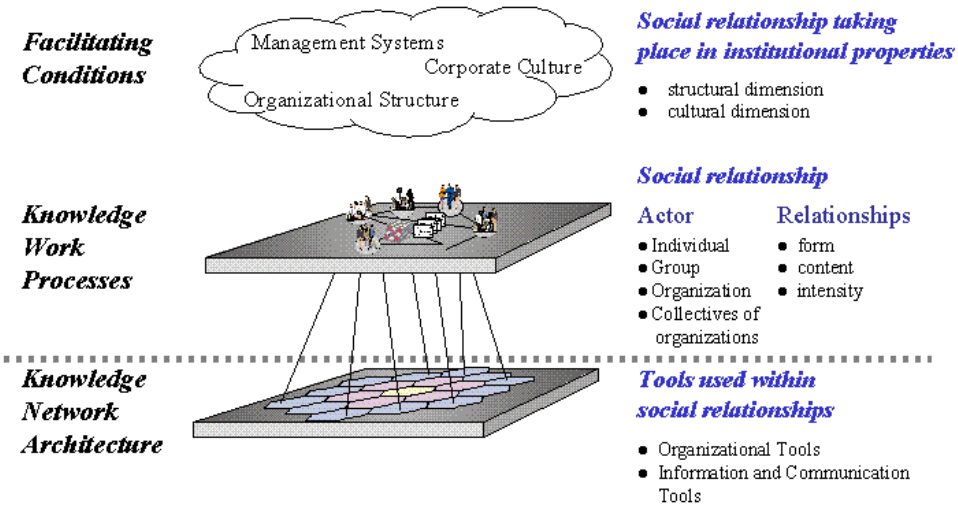

Figure 1: Framework Knowledge Networks - a micro perspective

1.2.1 Facilitating conditions

In our understanding knowledge networks are rather an additional, cross-divisional, dynamic layer than a new kind of organizational structure. In this regard, the macro-perspective on knowledge networks needs to take into account the interdependence of knowledge networks, as well as their role within their existing organizational units. In order to develop high-performing knowledge networks, the networks have to be synchronized by facilitating conditions. We divided those into structural (e.g. organizational structure, management systems) and cultural (e.g. corporate culture, organizational behavior) dimensions.

From within knowledge networks (micro perspective), facilitating conditions are comprised of the network's internal structural and cultural dimensions in which knowledge work processes take place. Therefore, they define the environment for knowledge creation and transfer either as enablers or inhibitors.

1.2.2 Knowledge work processes

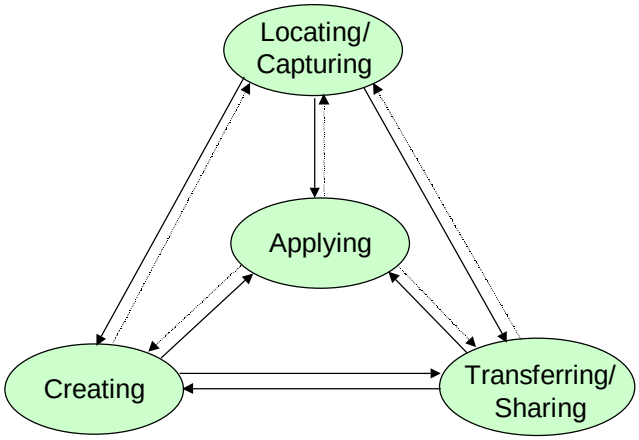

Figure 2: Knowledge process categories

In our initial framework we defined knowledge work processes in terms of locating and capturing knowledge, transferring and sharing knowledge, knowledge creation, as well as knowledge applying (see figure 2) as the main categories. Especially knowledge application is important, since the bottom line for all categories is the use of existing or newly gained knowledge in creating value for the customer and ultimately for the organization itself. In our model of knowledge work processes, the application of knowledge takes a central role by indicating that knowledge should not be managed for its own sake, but for its use in propelling business drivers.

1.2.3 Knowledge network architecture

Knowledge network architecture, finally, contains a set of tools used within social relationships. These include organizational tools, such as the role of the knowledge activist [von Krogh/Nonaka/Ichijo 1997], but also Information and Communication Technology (ICT) tools like, for example, the groupware-enabled data warehouse concept [Seufert 1997] designed to enable and improve knowledge work processes [Nonaka/Reinmoeller/Senoo 1998].
This architecture is not only a collection of modular tools. In the form of “solution frameworks” we develop architectural designs that are a combination of ICT and organizational tools.

We will examine this layer of the framework more closely. For this reason, we first look at some criteria which could be used to classify tools (see section 2). Following that, we will present an overview of Information and Communication Technology (ICT) tools and of organizational tools. In section 4, we will describe some selected tools in more detail. However, regarding the vast number of tools, these descriptions must be quite short and will therefore

be limited to an overview of each tool. This working paper concludes with an outlook, given in section 5. The tool classification tables which are used in this paper are listed in the appendix in blank format, in order to give the partners and readers the opportunity to use these sheet patterns for their own tool classification.

2 CRITERIA CATALOG FOR TOOL EVALUATION

2.1 Initial Situation

For several reasons, presenting a survey of tools that support knowledge networks is not a simple task. The difficulties of such tool evaluation include the following:

- To support knowledge networks, a wide array of tools come into consideration. In accordance with the aims of the Competence Center Knowledge Networks, the evaluation, collection, and research on tools should contain both ICT tools and organizational tools. This prompts a wide spectrum of heterogeneous tools which can all be used in various ways within knowledge networks.
- In order to describe ICT tools and organizational tools in a systematical way, appropriate criteria are needed to classify a tool or to compare it with others. However, the whole range of tools which provide support for knowledge networks cannot be covered by one homogenous criteria catalog for all tools.
- Further, within the two tool categories – organizational and ICT tools - numerous different tool classes can be identified, all of which are based on different concepts. In turn, each tool class is comprised of numerous tools which differ in their functional scope and other features.

In its entirety we are faced with a large body of tools, which can only be estimated and compared upon condition. The diversity of the tools renders one congruent homogeneous criteria catalog to evaluate and compare all of the tools unreasonable, if not impossible.
Another aim of our research work within the Competence Center Knowledge Networks is to allow the best possible integration of the research findings on tools within the framework set by the overall research. This means, that some criteria have to be found that show how organizational and ICT tools stand in relationship with other components of the framework, for example, knowledge processes.
In the following paragraphs we will suggest a solution to the problems pictured above. The following chapters will then demonstrate how the developed tool classification framework with its classification criteria can be used in praxis.

2.2 Building of tool classes and tool subclasses

A first step towards approaching the tool survey can be taken by considering which tool classes can actually support knowledge networks. This first step appears reasonable, since it limits the tool categories and focuses our attention on those appearing especially relevant.

Within those determined tool classes, we can classify and determine the important tools, providers, products, etc. in each case. Some kind of limitation is necessary, since otherwise the entire project of the tool evaluation and collection becomes too extensive.
In the case of ICT tools these tool classes quite often can be further differentiated. For example, subclasses of different tools can be formed in each tool class. Of course, it is not possible to build such tool classes and/or subclasses for every tool. For the organizational tools, described in this working paper, no subclasses will be defined. Furthermore, it can be stated that the building of classes is not a completely orthogonal process, meaning that the tool classes can overlap partially (e.g. overlapping of tool (sub-)functions).
Nevertheless, even if the building of tools classes does not solve all of the tool classification problems, it can be used among others as a helpful 'guideline' or 'roadmap' for tool evaluation within the Competence Center Knowledge Networks. Therefore, the definition of relevant tool classes (and possible tool subclasses) can be defined as a first step - for ICT tools as well as organizational tools - in determining which tools should be considered in the course of tool evaluation.

2.3 Choice of criteria for tool evaluation

In a next step, after having defined different tool classes, criteria to analyze and classify the tools can then be formed for each tool class.
Here, a central question is: In how much detail these criteria should describe the respective tools? On the one hand, criteria make it possible to classify and compare the tools. On the other hand, the danger exists, to end in an over-involved and needlessly extensive analysis, if the criteria catalog becomes too detailed. Moreover, not every criterion will bring the same benefit for the tool collection. Accordingly, the goal should be to define a well-balanced criteria catalog for each tool class which is limited to essential and benefit-bringing criteria.
These criteria for ICT and organizational tools will later be described in more detail. Not astonishingly, some criteria will differ for ICT and organizational tools. This is especially true for general and specific criteria. Other criteria, such as the linkage with the CC framework and the criteria dealing with integration, however, are valid for both types of tools.

2.3.1 General and specific criteria ICT Tools

Such a criteria catalog must first contain **general criteria** which can be employed for all of the ICT tool classes. Such general criteria for ICT tools can be:

General criteria for ICT tools
Product name
Current version/release
Date of market entry
Manufacturer
Number of installations
Reference customers
Platform requirements
Pricing

Table 1: General criteria for ICT tool evaluation

These general criteria can be applied only to ICT tools. These general criteria do not fit organizational tools, since they normally do not have, for example, a manufacturer (with the exception of commercial organizational tools).
The general criteria already deliver some clues, but they are still too general to allow statements about the functionality of ICT tools. Therefore, the general criteria must still be complemented with **specific criteria** for every ICT tool class. Those specific criteria also allow the comparison of the different tools contained in a tool class.
An example of specific criteria for the ICT tool class ‚Search tools' may be as follows:

Specific criteria for ICT tools
Full text search and/or keyword search
Different search operations
Actuality of search
Search via different networks
Search according to different file types
Quality of search

Table 2: Example - Specific criteria for ICT tool evaluation

In the following chapters we no longer refer to the general and specific criteria for ICT tools. Nevertheless, we mentioned them here for two reasons: On the one hand, to complete the criteria catalog, on the other hand, to later use them in the assessment of concrete tools in the course of further tool evaluation within the Competence Center.

2.3.2 Specific Criteria for Organizational Tools

For organizational tools, the general and specific criteria of ICT tools do not fit. Rather, the following criteria seem appropriate for an additional classification and a better understanding of organizational tools (see table 3):

Specific criteria for Organizational tools
Monetary incentives
Short-term applicable
Long-term applicable
Short-term effective
Long-term effective

Table 3: Specific criteria for organizational tool evaluation

2.3.3 Criteria for linkage with CC framework

For the Competence Center Knowledge Networks, it is particularly important to associate and integrate the organizational and ICT tools and their respective tool classes with the CC framework. For this, components of the CC framework can serve as further criteria to classify the tools:

Kind of tool	Organization tool ICT tool
Tool class/Underlying concept	
Support level	Individual Team Organization
Support of knowledge processes	Creating Locating & Capturing Sharing & transferring Applying
Support of network lifecycle	Network building Network performance Network rebuilding/regression
Support of knowledge objects	Explicit knowledge Implicit knowledge

Table 4: Criteria for linkage with CC framework

For example, this classification allows making statements about which particular knowledge processes a tool supports, which stage within the network life-cycle is supported, which specific knowledge objects are supported, and so forth.[1]
In section 3 and 4 of this paper we primarily make use of the criteria for linkage with the CC framework and apply them to the tool classes we discuss here.

2.3.4 Criteria for integration

Our work on tools in the Competence Center should not consider the individual tools in an isolated manner. Rather, it should also examine the suitability of the tools in supporting knowledge networks within a comprehensive architecture (which at the present state of the CC research work is not yet developed), which implies that the aspect of **integration** also

[1] A similar framework for characterizing knowledge management methods, practices and technologies has been proposed by Newman/Conrad, 1998.

plays an important role. Therefore, criteria for the assessment of the integration abilities and possibilities of the tools should be included into the criteria catalog. The question about available **interfaces** to the direct technical and organizational environment of the tool is closely associated with the importance of integration.
Taking this into consideration, the following criteria and questions should be looked at:

Integration object	Main questions
Integration knowledge processes	Which knowledge processes are integrated by the tool? Which interfaces to other knowledge processes do exist?
Integration support levels	Which level is supported by the tool? Individual, team, organization? Which interfaces to other levels are available?
Integration of knowledge objects (explicit and implicit knowledge)	Which knowledge is integrated by the tool? Which interfaces exist? How do the ‚transformations' between implicit knowledge and explicit knowledge look like?
Integration organization/ICT	How can organization and ICT be integrated?
Integration technology	Are different platforms supported? Which one?

Table 5: Criteria for integration

The topic of integration becomes particularly relevant, when different ICT tools and organizational tools should be combined. This might be the subject of further research. However, in this contribution we limit the scope by excluding the questions regarding integration and by not making use of the integration criteria in the following chapters. Nevertheless, we will use them for the further assessment of concrete tools within the Competence Center.

2.4 Structure of the criteria catalog

The following structure of a criteria catalog results from the different criterion groups mentioned above:

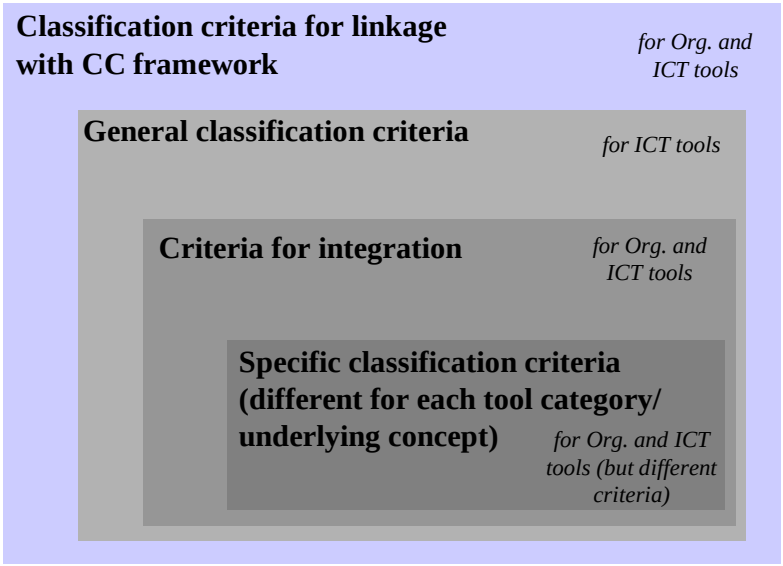

Figure 3: Structure of the criteria catalog

Since all tool features and qualities can never be pressed into a structured description matrix, the criteria catalog should be complemented by a short description of the respective tool and its most central qualities. This has been done in this working paper for several tool classes (see chapter 4) and also for the tool collection. The results are stored electronically on the CC web platform (http://www.knowledgesource.org).

2.5 Action steps towards a tool collection

In general, the collection, description and classification of tools for the Competence Center Knowledge Networks should occur in a planned manner, in order to avoid a random and non-directional gathering of tools. Due to the above considerations, the tool evaluation for the Competence Center should consider , if possible, a definition and description of relevant tool classes for the support of knowledge networks in the fields of ICT tools and organizational tools. The result of this process can be pictured as a kind of 'tool map' that can be used as a guideline for the evaluation and for the judging of its progress. Further, it is necessary to describe the tools in the respective tool class and to classify them according to the criteria catalog explained above.

The main advantage of such a procedure is that evaluating individual tool classes already supplies a visible contribution to the Competence Center, even if other tool classes still have not been evaluated. In this sense, the tool classes can be used as a kind of 'roadmap' to easily recognize the current state of the tool evaluation.

With regard to the Competence Center Knowledge Networks, one of the main focuses of the tool evaluation, is that the described tool classes and tools can serve as building blocks for the development of an overall architecture to support knowledge networks. To provide immediate results, the results of the tool evaluation are filed on http://www.knowledge-source.org, where the classification scheme is also implemented on the web platform of the Competence Center.

In the following, the relevant tool classes found for organizational and ICT tools will be presented. Also, an overview of organizational and ICT tools will be given. Additionally, using the developed classification scheme, some of the tool classes as well as selected tools will be described in more detail. However, because of the enormous mass of tool classes as well as of tools, it is not possible to discuss all of them in this paper. Rather, a selection – which is marked below – will be presented.

3 OVERVIEW: ORGANIZATIONAL AND ICT TOOLS

3.1 Tool Classes for Organizational and ICT Tools

In this section of the paper we present an overview of those tool classes for organizational and ICT tools, which we consider to be relevant for the tool support of knowledge networks. As already mentioned, such a survey can hardly be complete, since nearly every ICT tool and various organizational tools might in some way be able to contribute to the support of knowledge networks. Nevertheless, this collection gives a good impression of the most important tool classes.

For the field of the ICT tools, the following tool classes have been identified (see figure 4) as relevant for the support of knowledge networks:

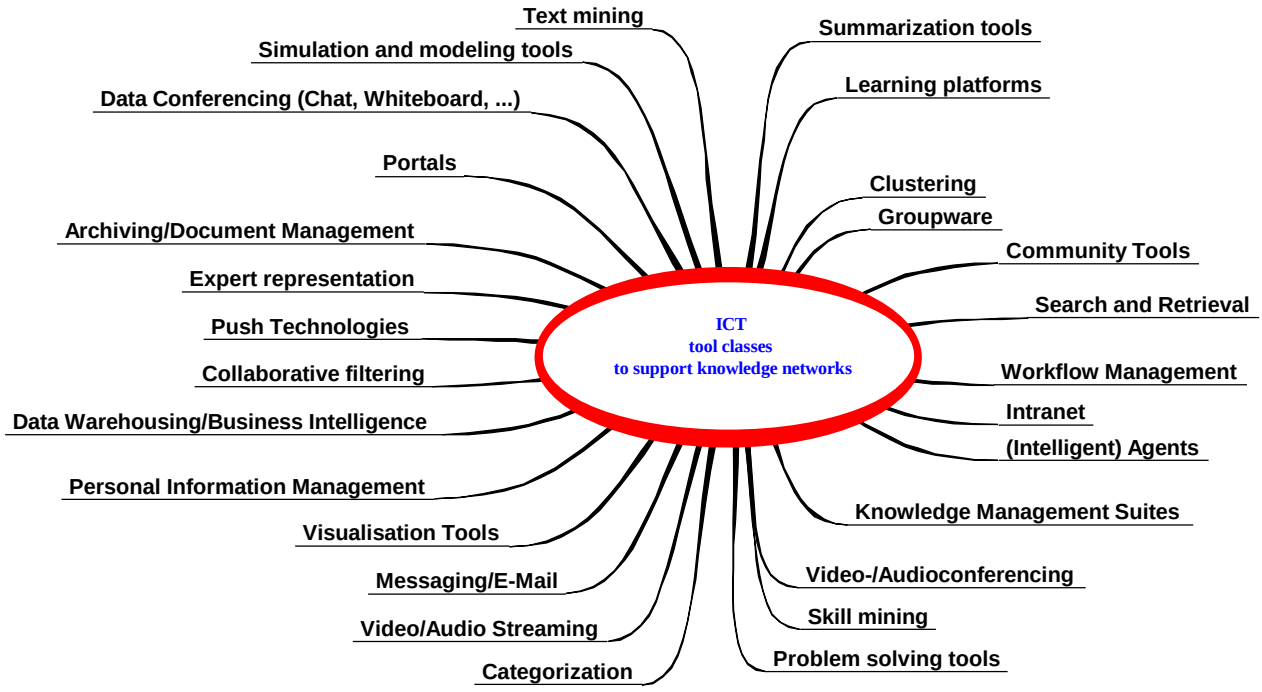

Figure 4: ICT tool classes to support knowledge networks

As already discussed under 2.2, tool subclasses can quite often be developed, especially for ICT tools. For the tool class ‚Data Warehousing/Business Intelligence', this would be, for example, the following subclasses:

- Online analytical processing tools (OLAP),
- Reporting Systems,
- Management Information Systems/Executive Information Systems,
- Decision Support Systems,
- Data Mining Systems,

- Business Support Systems.

Since those subclasses also have to be taken into consideration, the palette of possible tools that support knowledge networks becomes even broader. The tool evaluation is surely not made easier by the mass of available tools and the fact that the ICT tool market is rather dynamic, with new tools arising continuously.

In the field of the organizational tools, the following tool classes (see figure 5) can be distinguished:

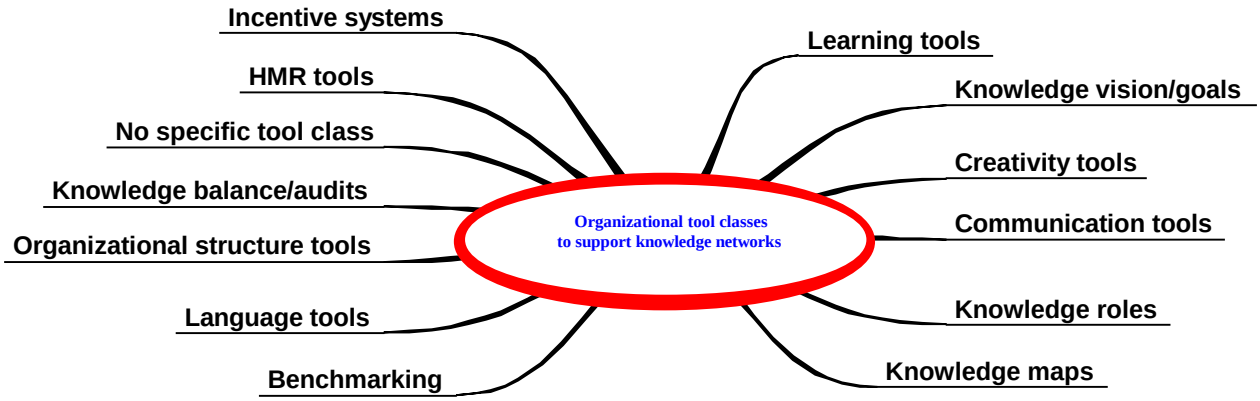

Figure 5: Organizational tool classes to support knowledge networks

3.2 At a glance: Organizational and ICT tools

After having given a short overview of the separate, relevant ICT and organizational tool classes, we will now attempt to display ICT and organizational tools together in a comprehensive 'at a glance - tool map' (figure 6) which will be enhanced by including some tools or tool subclasses according to their respective tool classes.

To represent ICT and organizational tools together in one map, further underlines our intention to have an integrated approach to both types of tools. This is also the reason why, in chapter 4 of this paper, we don't further differentiate and divide ICT tools and organizational tools, but still assign them to the supported knowledge processes.

Figure 6: Organizational and ICT tools

3.3 Overview: Tools and Knowledge processes

In the following, we now turn our attention to the question regarding which of the discussed tool classes can best support knowledge work processes in networks. This question is important, because not all tool classes have the same ability to cater to the goals of knowledge management initiatives in companies as well as, to the choosing of the knowledge to be supported in an adequate and efficient fashion. Table 6 should help clarify, which tool classes are suitable to help which corresponding knowledge process/processes. Awareness of which tool classes are able to support which different knowledge work processes is an important step towards taking the right actions and to building the right tool set in the company.

	Creation	**Locating & Capturing**	**Transferring & Sharing**	**Applying**		**Integration of knowledge processes**
ICT tools						
Intranet	■	■	■			■
Groupware	■	■	■			■
Community Tools	■		■			
Search and retrieval		■				
(Intelligent) Agents	■	■	■			
Knowledge Management Suites	■	■	■	■		■
Video/Audio Conferencing			■			
Data Conferencing			■			
Video/Audio Streaming			■			
Messaging/E-Mail			■			
Visualization Tools	■	■		■		
Personal Information Management (PIM)	■	■	■	■		■
Data Warehousing/Business Intelligence	■	■	■			
Push Technologies			■			
Archiving/Document Management	■	■	■			
Text mining	■					
Learning platforms			■	■		
Enterprise Portals	■	■	■	■		■
Simulation and modeling tools	■			■		

Workflow Management						
Summarization tools						
Clustering						
Skill mining						
Categorization						
Collaborative filtering						
Expert representation						
Problem solving tools						

	Creation	**Locating & Capturing**	**Transferring & Sharing**	**Applying**		**Integration of knowledge processes**
Organizational tools						
Knowledge maps						
Language tools						
Creativity tools						
Benchmarking						
Learning tools						
Knowledge vision/goal tools						
Incentive systems						
Organizational structure tools						
Knowledge roles						
HMR tools						
Communication tools						
Knowledge balance/audits tools						
No specific tool class		Vary-ing....	.....			

Table 6: Tools and knowledge processes

In addition to the columns knowledge processes creation, locating and capturing, transferring and sharing, as well as applying, we incorporated an additional one named integration. Here, integration concerns the integration of different knowledge work processes. Tools which are pointed out to be helpful for integration support all knowledge processes and can integrate the varying knowledge processes by giving standards etc. This includes tools which, on the one hand, can support all knowledge processes and, on the other hand, can integrate the varying knowledge processes by, for example, setting standards.

4 DESCRIPTION: ORGANIZATIONAL AND ICT TOOLS

4.1 Organizational and ICT Tools Described In This Paper

After explaining the criteria for tool evaluation (chapter 2), giving an overview on ICT and organizational tool classes and tools (chapters 3.1 and 3.2), and discussing which tool classes can support different knowledge work processes (chapter 3.3), we will now shortly describe some tool classes and tools. Whereas for ICT tools, we paid more attention to tool classes, we described tool classes as well as single tools with respect to organizational tools. However, because of the enormous mass of ICT and organizational tool classes and tools, it is not possible to picture all of them. Figure 7 shows which tool classes and tools are selected in this paper.

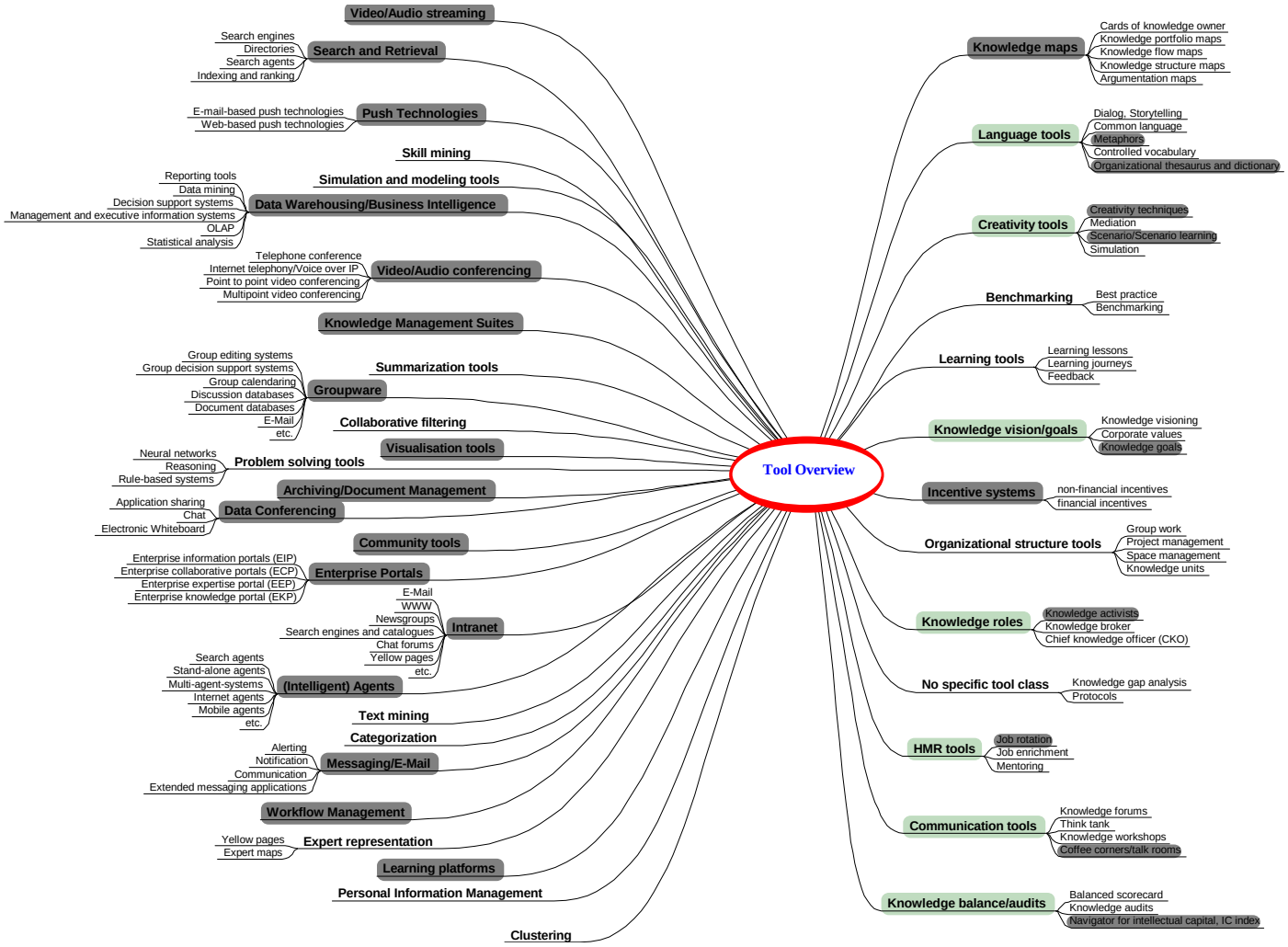

Figure 7: Organizational and ICT tools described in this working paper

As indicated in part 3.3, ICT and organizational tool classes and tools have a varying ability to support the different knowledge work processes. Also, many of them do not just support one process, but can support different ones. However, for the purpose of this paper, tool classes and tools have been assigned to the process which we believe they support most. According to chapter 2, at the end of each tool class or tool description, the criteria for linkage to the CC framework as well as specific criteria for organizational tools are specified.

4.2 Knowledge Process 'Locating and Capturing'

4.2.1 Search and retrieval

Online searching is one of the oldest and most important business and knowledge management applications. The need for powerful search tools becomes particularly obvious with the rise of the World Wide Web. Today, text-retrieval tools are ubiquitous. Often they are part of a more comprehensive knowledge management solution. Additionally, **agents** can be used to automate the search process (see 4.2.2). Typically, retrieval tools provide a unified search interface for multiple document repositories on the company's Intranet as well as for those documents distributed across the Internet.

Search engines are tools which make it possible to search huge indexes of internet sites or of documents for particular words or phrases. A search engine lets the user enter key words representing the pages of information to specify the topic. The search engine will check its index and immediately display any hypertext links to pages or documents that contain the user's keywords.

While none of the search engines cover the entire Internet, the larger ones include millions of Internet sites. When searching for a broad topic that uses common, frequently occurring words, a search engine will find many sites that, while containing a mention of the search term, have little to do with the desired topic. The user must then scroll through hundreds or thousands of sites to sort out the few useful resources. In such a situation, **directories**, which organize internet or intranet resources by placing them into subject categories, may be more useful than a search engine.

Search indexes are made up of 3 components:

- A software program (called a *robot* or *spider*) which roams the Internet collecting information from sites (Crawling)
- A database which stores the information collected by the robot (indexing and ranking)
- A search engine which scans through the contents of the database

Because search indexes vary in many ways (the number of internet sites included in the database, the types of information collected by the robot, the search options provided for users, etc.), using various search engines for the same search will often produce very different results. This might necessitate the use of several search engines.

Today, knowledge management is confronted with the problem that, although search and retrieval technologies are still getting better, it often remains too difficult and time-consuming to find the needed information within an intranet or the internet. Another problem that has to be faced in this context is that the number of web sites and other information sources increases permanently and at a increasingly fast pace.

Linkage to CC framework

Kind of tool	Organization tool **ICT tool**
Tool class/Underlying concept	**Search and retrieval tools**
Support level	**Individual** **Team** **Organization**
Support of knowledge processes	Creating **Locating & Capturing** Sharing & transferring Applying
Support of network lifecycle	Network building **Network performance** Network rebuilding/regression
Support of knowledge objects	**Explicit knowledge** **Implicit knowledge (e.g. searching for experts)**

Product examples	WWW-Address
Excalibur RetrievalWare	www.excalib.com
Microsoft Index Server	www.microsoft.com
Verity Search 97	www.verity.com
PCDOCS/Fulcrum DOCSFulcrum	www.pcdocs.com
Sovereign Hill's Inquery	www.sovereign-hill.com

4.2.2 (Intelligent) Agents

Software agents are a class of software that act on behalf of the user in, for example, finding and filtering information, negotiating for services, automating complex tasks, or collaborating with other software agents to solve complex problems. The definitions of an agent follow a continuum, from simple macros in which the user enters a few parameters to truly intelligent agents, which demonstrate learning ability and artificial intelligence and are therefore able to improve their performance in executing tasks. Closely related to the term agent and almost a synonym is the term **robot** or short **bot**.

Intelligent agents are most intensively studied in the discipline of **Artificial Intelligence (AI)**. Such an agent can be defined as a dynamic (autonomous, social, reactive) software entity (service, application, object) that is self-contained and performs tasks on behalf of a user or of a user-initiated process usually in a distributed environment [Brethenoux/ Block 1995].

The central idea underlying software agents is that of delegation. The owner or user of a software agent delegates a task to the agent and the agent autonomously performs that task on behalf of the user. The agent must be able to communicate with the user to receive its instructions and provide the user with the results of its activities. Finally, an agent must be able to monitor the state of its own execution environment and make the decisions necessary for it to carry out its delegated tasks.

Agents can be additionally characterized with many behavioral and technical attributes (i.e., autonomy, reactivity, mobility, adaptability, personality, collaborative behavior, event driven, self-contained). In the literature, several types of agents are described (i.e., collaborative agents, internet agents, information agents, search agents, smart agents, mobile agents).

There are two main approaches to building agent based systems; the developer can utilize a single stand-alone agent or implement a multi-agent system. A **stand-alone agent** communicates only with the user and provides all of the functionality required to implement an agent-based program. **Multi-agent systems** are computational systems in which several agents cooperate to achieve some task that would otherwise be difficult or impossible for a single agent to achieve.

Intelligent agents can automate and support a wide array of tasks within the enterprise (i.e., from monitoring streams of data to proactively detecting certain events, to assisting the management and retrieval of information). Agent technology is often implemented in knowledge management tools (i.e., Lotus Notes, Autonomy).

Linkage to CC framework

Kind of tool	Organization tool **ICT tool**
Tool class/Underlying concept	**(Intelligent) agents**
Support level	**Individual** Team Organization
Support of knowledge processes	**Creating** **Locating & Capturing** Sharing & transferring Applying
Support of network lifecycle	Network building **Network performance** Network rebuilding/regression
Support of knowledge objects	**Explicit knowledge** Implicit knowledge

Product examples	WWW-Address
Agent-based products	
Autonomy Agentware	www.autonomy.com
Verity Agentserver	www.verity.com
Lotus Notes	www.lotus.com
Open Sesame	www.opensesame.com
Agent development	
Agentbuilder	www.agentbuilder.com
Microsoft Agent	www.microsoft.com

4.2.3 IC Navigator

The IC navigator belongs, according to our classification scheme, to the tool class knowledge balance/audit tools. The IC navigator was created by Skandia Assurance and Financial Services. The major goals of this tool are to measure and visualize intellectual capital, which is mostly hidden, in order to show a balanced picture of financial and intellectual capital [based on Edvinsson/Malone 1997 and on Intellectual Capital Prototype Report of Skandia 1998: also the following information base on those sources]. Intellectual capital, as defined by Skandia AFS, comes in the form of human capital (all the individual capabilities) and structural capital (everything that remains when the employees go home, such as infrastructure). The IC-Navigator has a focus on 5 different areas: a financial focus, a market focus, a process focus, a human focus, as well as a renewal and development focus (see figure 7).

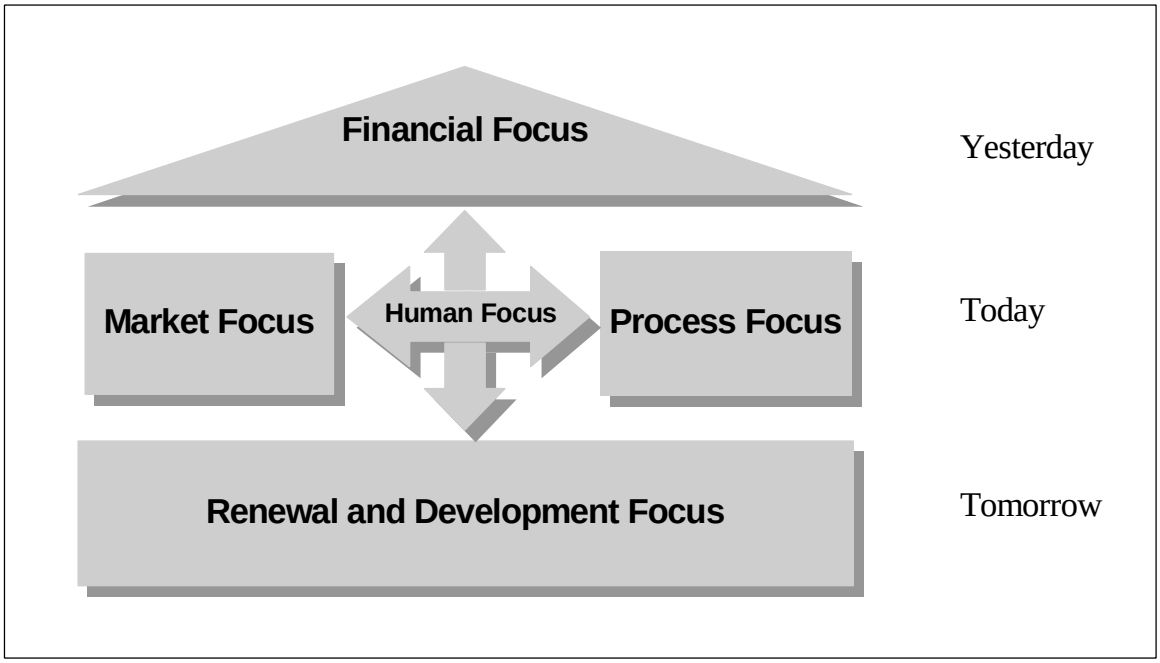

Figure 8: IC- Navigator

To make the different areas usable and measurable, IC indicators are used to translate each focus into useable measures. Examples of IC indicators are listed in the following table 7:

Examples of IC indicators financial focus	**Examples of IC indicators customer focus**	**Examples of IC indicators process focus**	**Examples of IC indicators renewal and development focus**	**Examples of IC indicators human focus**
• Income/ employee ($) • Market value/ employee ($) • Return on net assets resulting from a new business operation ($)	• Number of customer accounts (#) • Days spent visiting customers (#) • Satisfied customer index (%)	• Applications filed without error (#) • Processing time, out-payments (#) • Contracts/ employee (%)	• Satisfied employee index (#) • Competence development expense/ employee ($) • Training expense/employee ($)	• Empowerment index (of 1,000) (#) • Time in training (days/year) (#) • Motivation index (%)

Table 7: Examples of IC- Indicators

Linkage to CC framework

Kind of tool	**Organization tool** ICT tool
Tool class/Underlying concept	**Knowledge balance/audit tool**
Support level	Individual **Team** **Organization**
Support of knowledge processes	Creating **Locating & Capturing** Sharing & Transferring Applying
Support of network lifecycle	Network building **Network performance** **Network rebuilding/regression**
Support of knowledge objects	**Explicit knowledge** **Implicit knowledge**

Monetary incentives	Yes **No**
Short-term applicable	Yes **No**
Long-term applicable	**Yes** No
Short-term effective	Yes **No**
Long-term effective	**Yes** No

4.2.4 Knowledge Maps

Knowledge maps are used quite often. A knowledge map – physical or in a database – can be defined as a graphic guide which shows the location of knowledge. It is not a repository which contains knowledge [accordingly to Davenport/Prusak 1998 and to Probst/Raub/ Romhardt 1997; also the following information base on these two sources whereby table 8 is especially based on the latter one). The main purpose of a knowledge map is to show people where to go and whom to ask when they need expertise or help. It shows access possibilities to knowledge sources (people, documents, databases) that would otherwise be difficult find. Also, it can be used as an inventory which indicates what knowledge exists in the organization– and what knowledge doesn't exist (knowledge gap) - and where it is located.
Knowledge maps can appear in different forms. The different types of knowledge maps are listed in table 8:

Types of knowledge maps
Cards of knowledge owner
Knowledge topography
Competence maps
Pointer systems
Knowledge source maps
Knowledge portfolio maps
Knowledge flow maps
(e.g. Intop mapping)
Knowledge structure maps
Concept mapping
Clustering
Schematizing
Relational mapping
Argumentation maps

Table 8: Types of knowledge maps

Very often knowledge maps are created by using surveys that ask employees about their knowledge, what they could provide and share with others, as well as where they get the knowledge they need to do their jobs. These responses are then consolidated. Recommendations can also help to generate a knowledge map. Further, explicit knowledge like that residing in employees' written documents, for example, are documented in the knowledge map.

Linkage to CC framework

Kind of tool	**Organization tool** ICT tool
Tool class/Underlying concept	**Knowledge maps**
Support level	**Individual** **Team** **Organization**
Support of knowledge processes	Creating **Locating & Capturing** Sharing & Transferring Applying
Support of network lifecycle	Network building **Network performance** Network rebuilding/regression
Support of knowledge objects	**Explicit knowledge** **Implicit knowledge**

Monetary incentives	Yes **No**
Short-term applicable	**Yes** No
Long-term applicable	**Yes** No
Short-term effective	**Yes** No
Long-term effective	**Yes** No

4.3 Knowledge Process 'Sharing and Transferring'

4.3.1 Workflow management

The term workflow management usually means the control of the workflow between all persons and/or work places involved in a business process. Workflow Management typically considers and supports well-structured, organization-wide business processes in which many persons are to be involved. Since workflow management also tries to support less structured workflows (i.e., ad-hoc workflows, collaborative workflows), the boundaries to 'Workgroup Computing' - which typically describes the computer-based, common processing of non-scheduled, non-structured tasks in a rather small team - are blurred.

In the course of workflow automation, business processes and related tasks should be carried out faster and more efficiently with the aid of software based workflow management systems. The analysis, definition, reengineering and administration of the information flow within the companies internal processes are central tasks of workflow management. As a result, data and/or documents can be transmitted electronically to other employees, which shortens the transport times of data/documents between the work places. Transaction processing with workflow management systems is supported by document management systems, making the common processing of informal, 'soft' information possible.

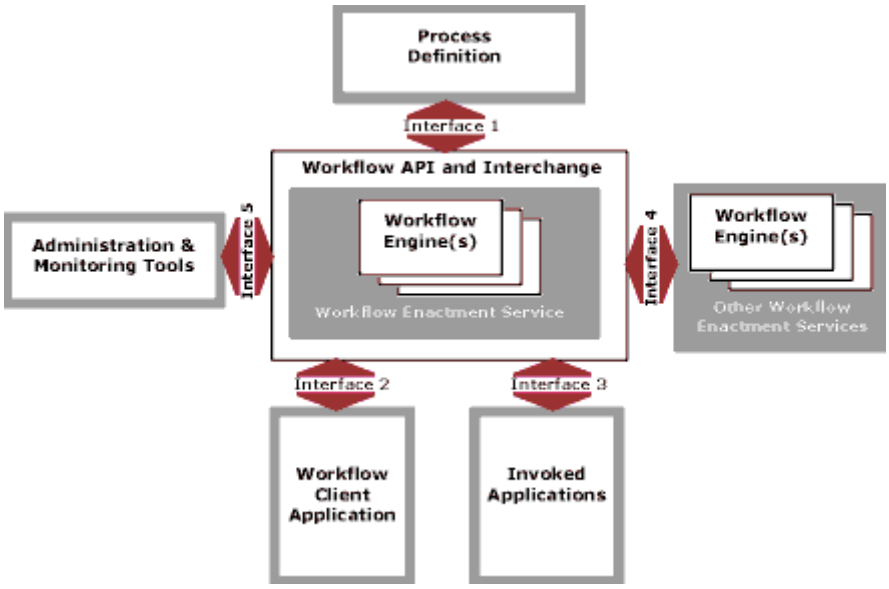

Figure 9: Workflow reference model [WfMC 1999]

Linkage to CC framework

Kind of tool	Organization tool **ICT tool**
Tool class/Underlying concept	**Workflow Management**
Support level	Individual **Team** **Organization**
Support of knowledge processes	Creating Locating & Capturing **Sharing & transferring** Applying
Support of network lifecycle	Network building **Network performance** Network rebuilding/regression
Support of knowledge objects	**Explicit knowledge** Implicit knowledge

Product examples	WWW-Address
IBM Flowmark	www.ibm.com
Staffware 2000	www.staffware.com
Action Technologies	www.actiontech.com
Eastman Software Workflow	www.eastmansoftware.com
Ultimus Workflow	www.ultimus1.com
Standardization	
Workflow Management Coalition	www.wfmc.org

4.3.2 Messaging/E-Mail

The term E-mail (electronic mail) designates systems for transportation of electronic messages. E-mail systems allow the paperless exchange of various types of data, since different file types (text, graphics, WWW documents, audio, video, etc.) can be attached to an e-mail message.

Just like the World Wide Web, basic e-mail service is also based on the client-server principle. For message transfer between mail clients and mail servers different standardized transport protocols have been developed (SMTP, IMAP4, LDAP, S-MIME, POP3, X.400,

X.500 and so forth). Specific gateway computers execute the necessary conversion between the different protocols.

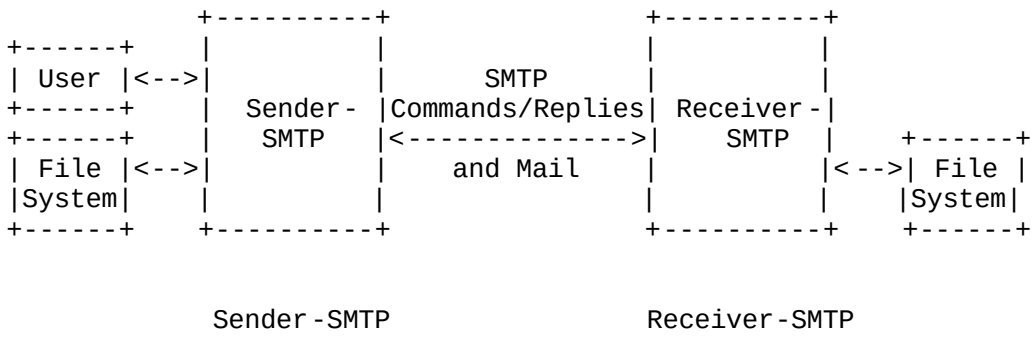

Figure 10: The basic SMTP architecture [RFC 821, 1982]

The operating principle of e-mail service was initially based on traditional mail; every user has their mailbox located on a mail server and can be identified through a unique e-mail address. In communication by e-mail a time-delay occurs (asynchronous).
However, the capability of e-mail systems goes far beyond that of traditional mail and this not only with respect to the transmission speed. Services like buffered storage of messages, 1:n communication, address and distribution listing, mail forwarding, as well as receiving and reading confirmations, are basic functions of e-mail and present a great improvement compared to traditional mail.
Advanced, integrated e-mail systems, which are also designated as messaging systems, contain a great number of additional functions and application features, such as:

- Integration into standard applications
- Automatic classification and forwarding of messages, as well as the assignment to defined categories by means of filtering and ‘processing rules’
- , Intelligent' functions that allow structured communication for the e-mail system
- Integrated text processing and archiving

E-mail, which can be designated as a real ‘killer application’, has undergone a significant evolution during the last years. Originally implemented and used as a person-to-person communication system (to send, receive and process messages) and still most widely used as such, today e-mail is also used as an advanced messaging infrastructure to support different applications such as groupware and other mail-based applications. For example, a calendar/scheduling system can generate e-mail messages to multiple recipients in order to schedule a meeting. Similarly, notifications of task assignments within a workflow system may arrive in the form of e-mail.

Today, e-mail is – next to the World Wide Web - the most important basic service of the internet and/or intranet and it is integrated into all standard web browser applications. Further, the still continuing growth of the internet ensures almost everyone having or getting an e-mail address. Among other benefits, this enables companies to establish new forms of communication and relationship management with their customers (CRM, Customer Relationship Management).

Another important trend concerning messaging/e-mail is **unified messaging**, which allows users to access all types of messages (e-mail, phone, fax, etc.) from one single terminal: either the desktop PC, a notebook PC, or the telephone.

It is clear that e-mail and advanced messaging play a central role – for example, as a worldwide, basic communication, and collaboration tool or as an alert and notification service - within the company's knowledge management infrastructure.

Linkage to CC framework

Kind of tool	Organization tool **ICT tool**
Tool class/Underlying concept	**Messaging/E-Mail**
Support level	**Individual** **Team** **Organization**
Support of knowledge processes	Creating Locating & Capturing **Sharing & transferring** Applying
Support of network lifecycle	**Network building** **Network performance** Network rebuilding/regression
Support of knowledge objects	**Explicit knowledge** **Implicit knowledge**

Product examples	WWW-Address
MS Outlook	www.microsoft.com
Lotus Notes	www.lotus.com
Netscape Messenger	www.netscape.com
Eudora Pro	www.eudora.com
E-Mail provider	
HotMail	www.hotmail.com
Yahoo! Mail	http://mail.yahoo.com
AOL	www.aol.com
Standardization	
International Standardization Organization (ISO)	www.iso.ch
Internet Engineering Task Force (IETF)	www.ietf.org

4.3.3 Video-/Audio conferencing

Video conferencing, in its most basic form, is the transmission of images (video) and vocals (audio) between two or more physically separate locations. This is accomplished through the use of cameras (to capture and send video), video displays (to display received video), microphones (to capture and send audio), and loudspeakers (to play received audio). Further, video conferencing can be point-to-point (between two endpoints), or multi-point (combining two or more endpoints into the same "conversation"). The combination of diverse endpoints into one setting, in which audio and video from each can be shared in real-time, enables entirely new levels of interaction and can prompt a completely new type of communication.
In contrast to the definition above, **audio conferencing** signifies the use of voice communication equipment to allow geographically dispersed people to communicate in real time. There are several ways to establish an audio-conference. Usually audio conferencing takes place via standard phone lines. The first form of audio conferencing was the telephone conference call, where typically a group of telephone users provide a list of their names and phone numbers to a central telephone exchange. At a pre-arranged time the exchange calls each party and connects them to a shared telephone conversation, enabling every participant to communicate with all the others.
A hands-free telephone is often used in an audio-conference. The telephone uses a loudspeaker to broadcast the incoming messages and a sensitive microphone to transmit voice messages. Today, audio conferencing can also be performed via an IP-Network like the Internet (**internet telephony, voice-over-IP**). Through a gateway, Voice-over-IP can also be used to access all telephone devices, not just those connected to an IP network.

Video-/Audio conferencing is currently still not a "plug-and-play" technology. The history of Video-/Audio conferencing is in many ways a history of restrictions, often caused by technologies that were proprietary and incompatible. As time has gone on, these restrictions have softened. Technology for conducting video conferencing has become less expensive, more flexible, and now includes options for desktop video conferencing as well as for group video conferencing. More ubiquitous network types - particularly TCP/IP, used on the Internet - are being called upon to provide less expensive and more flexible connections. In conjunction with this, new standards (i.e., H.323, H.324) have emerged for supporting audio/video conferencing through networks like TCP/IP.

Linkage to CC framework

Kind of tool	Organization tool **ICT tool**
Tool class/Underlying concept	**Video-/Audio Conferencing**
Support level	**Individual** **Team** Organization
Support of knowledge processes	**Creating** Locating & Capturing **Sharing & transferring** Applying
Support of network lifecycle	**Network building** **Network performance** Network rebuilding/regression
Support of knowledge objects	**Explicit knowledge** **Implicit knowledge**

Product examples	WWW-Address
Video-Conferencing	
PictureTel	www.picturetel.com
Intel Proshare	www.intel.com
Microsoft Netmeeting	www.microsoft.com
Videotalk	www.videotalk.co.uk
Internetphone with Video	www.vocaltec.com
Audio-Conferencing	
Autel Quicktalk	www.autel.com
Netphone	www.netspeak.com
Nettalk	www.nettalk.com
Netscape Cooltalk	www.netscape.com
Standardization	
International Telecommunications Union (ITU)	www.itu.org
International Multimedia Teleconferencing Consortium, Inc. (IMTC)	www.imtc.org

4.3.4 Video-/Audio streaming

Video-/Audio streaming is a 'broadcasting' method and technology for delivering video, audio, or other multimedia content to PC's via a network, such as the Internet. To say video or audio data is streamed means that it can be displayed while being sent, without the user having to wait for the content to download completely to his or her hard drive. In contrast to non-streaming data transmission, streaming data can begin with playback before it has been sent in its entirety to the client computer. This eliminates the lengthy process of downloading video clips for online viewing. Another advantage is, that only little storage space is needed at the client site (for buffering). A streaming multimedia server can tailor the data it transmits to the available network bandwidth and to the playback capabilities of the client workstation. To the end user, or viewer, streaming video plays as an immediate and ongoing broadcast. Through caching, content is played as it is received. Buffering mechanisms ensure that content is played smoothly.

An example how video/audio streaming can be used for knowledge management purposes, is the broadcasting of training or learning contents to a group of employees over an intranet.

Linkage to CC framework

Kind of tool	Organization tool **ICT tool**
Tool class/Underlying concept	**Video/Audio Streaming**
Support level	**Individual** **Team** **Organization**
Support of knowledge processes	Creating Locating & Capturing **Sharing & transferring** Applying
Support of network lifecycle	Network building **Network performance** Network rebuilding/regression
Support of knowledge objects	**Explicit knowledge** **Implicit knowledge**

Product examples	WWW-Address
RealNetworks RealServer	www.realnetworks.com
Microsoft Netshow Theater Server	www.microsoft.com
VDOLive Player	www.vdo.net
Apple QuickTime	www.apple.com

4.3.5 Data Conferencing

Data conferencing, which is (just like video-/audio conferencing) also a part of **real-time collaboration technologies**, can be defined as sharing information electronically, in real-time, between two or more people, and for the specific purpose of discussing the contents. Data conferencing includes key applications such as **screen sharing** (i.e., remote editing and viewing of a presentation), **application sharing** (i.e., joint editing within an application such as a spreadsheet, word processor or graphics program) and **chat**. Data conferencing is often combined with an audio conference or video conference, allowing a group to meet via PC's and, for example, discuss a presentation that can be electronically shared among all group members. The members can also use white-boarding software, allowing them to make notes or draw on a simulated "white board" or blank screen during the meetings. Data conferencing may also be extended with an **external electronic whiteboard** which is a large, touch-

sensitive screen attached to a PC. With the help of this technology and combined with video conferencing, real meetings can be transmitted to other locations. Standards, like the T.120 and H.320 standards family, allow data conferencing to be performed IP-based, platform and network independent, and so forth.

Chat, another form of real-time collaboration usually takes place in a shared space, called a chat room. A chat room is a place, where users of the internet can discuss and share ideas, by typing messages back and forth between two or more people. Users can also send graphics, animation, or images. The messages of all users connected to the same chat room are seen immediately.

Today, groupware vendors such as Lotus are starting to integrate real-time technologies such as chat, white-boarding and application sharing into their products, adding them to e-mail and threaded discussion capabilities.

Linkage to CC framework

Kind of tool	Organization tool **ICT tool**
Tool class/Underlying concept	**Data Conferencing**
Support level	**Individual** **Team** Organization
Support of knowledge processes	**Creating** Locating & Capturing **Sharing & transferring** Applying
Support of network lifecycle	**Network building** **Network performance** Network rebuilding/regression
Support of knowledge objects	**Explicit knowledge** **Implicit knowledge**

Product examples	WWW-Address
Lotus Sametime	www.lotus.com
Microsoft Netmeeting	www.microsoft.com

4.3.6 Push technologies

Push technology is referred to as a system in which a user receives information automatically from a network server. Push technologies are designed to send information and software directly to a user's desktop without the user actively requesting it. Unlike the traditional pull method of information retrieval, in which the user has to initiate a search, push technology delivers information automatically to a user's computer in a customized format at designated times usually based on a personal information profile. Not surprisingly, the language of push publishers or content providers is strongly influenced by television and radio. Customers can choose 'channels' with aggregated content (news, financial data, etc.) and the information is 'broadcast' to users.

There are two main types of push technologies:

1. **E-Mail-based push technology**. This is the most common method of push publishing. One form is to use mailing lists to send users/customers updated information about services, products or news, and so forth. Users continue to subscribe to the service if they value the information sent to their mailboxes. Email-based 'push publishing' has traditionally been text based. Since the mid-nineties, a variety of multimedia e-mail and Web-mail type of 'push' services, began to appear. These push services deliver multimedia HTML pages to a web browser mail client.
2. **Web-based push technology**. With the rise of the World Wide Web, push publishing has taken many new forms. Internet services have provided free software that allows users to choose the 'channels' of information that they want to receive. Microsoft and Netscape incorporated push technology into their browser releases in the form of receivers for 'channels' of content that can be distributed automatically to the users desktop. Today, push technology is also used to realize personalized web sites, called **web portals** or **enterprise portals** when they are built within a company.

Within companies, push technologies that offer complex user profiling and delivery options are becoming increasingly attractive means of delivering information specifically targeted to internal corporate use or customer service. New push technologies, among others, enable organizations to customize information for specific desktops or to manage customer profiles and target information delivery. Push technology is also used to automate the process of distributing and updating software applications, to fix bugs, and provide new drivers or deliver new software versions easily and automatically.

Automatically monitoring internal and external business conditions and notifying knowledge workers in case of a significant event, has been one of the great promises of push technology. In the past years, a problem with push technology has been its inability to accurately identify and deliver the right information to support "mission-critical" activities. This has led to network overload and overexposure of irrelevant information. New versions of push technol-

ogy from several vendors - which integrate disparate sources of internal and external information with event-creating business rules - are getting closer to actually executing on the technology's promise.

Linkage to CC framework

Kind of tool	Organization tool **ICT tool**
Tool class/Underlying concept	**Push technologies**
Support level	**Individual** **Team** **Organization**
Support of knowledge processes	Creating Locating & Capturing **Sharing & transferring** Applying
Support of network lifecycle	Network building **Network performance** Network rebuilding/regression
Support of knowledge objects	**Explicit knowledge** Implicit knowledge

Product examples	WWW-Address
Pointcast	www.pointcast.com
Marimba	www.marimba.com
BackWeb	www.backweb.com
NetDelivery	www.netdelivery.com
InterMind	www.intermind.com
DataChannel	www.datachannel.com
BroadVision One-to-One	www.broadvision.com

4.3.7 Document Management

As much as database management software organizes and maintains the integrity of structured data, document management provides the same or similar capabilities for unstructured and semi structured information in documents. Today, the term ‘document’ has come to mean almost any file that can be created or stored in paper based format or electronically, including text, forms, database reports, graphics, images, spreadsheets, and even sound and video.

Document management can also be defined as the process, whereby paper based information is digitized and stored electronically (on a PC, CD-ROM, etc.), via imaging, streamlining, and speeding up the access and flow of information. Document management is often seen associated with the vision of the ‘paperless office’. A critical success factor of document management in modern business is that, with the possibility of immediate accessibility of information, productivity and information exchange are becoming more constrained due to the inherent limitations of paper based information systems.

Core functionalities of **document management systems** (DMS) are the allocation of access rights, controlled and collaborative document access (check-in/check-out process), storing, tracking, versioning, indexing, searching for documents, among others. Document management also includes optical archiving systems and image processing, which require extensive storage solutions, special hardware, and tight integration between the document management system’s software and hardware components. Further, document management systems are often delivered as so called ‘document management suites’ which are enhanced with workflow and groupware functionality.

A main function of document management systems is, managing the **document lifecycle** by supporting the processes of document creation, modification, security, review and approval, workflow, distribution/publishing, and archiving.

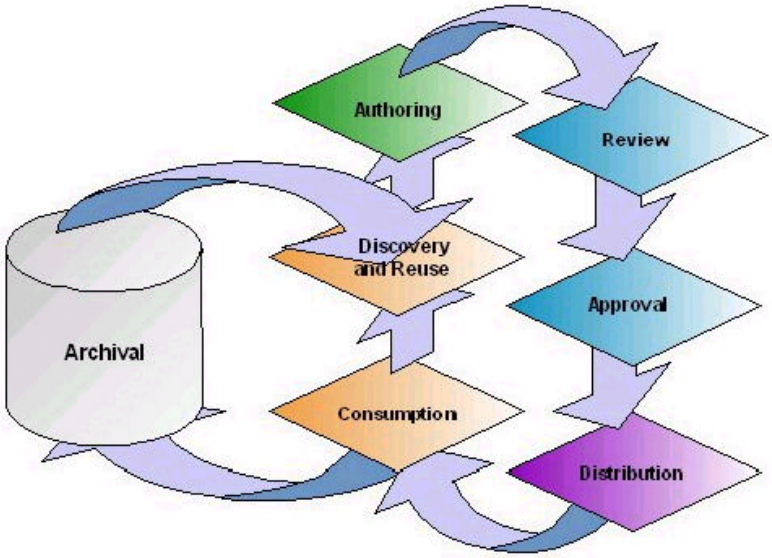

Figure 11: Document lifecycle management [Lotus 1999]

Today and in the foreseeable future, document management systems can be regarded as an essential precondition for knowledge management. Knowledge management, document management and workflow technologies will continue to evolve into more unified knowledge management environments. Document management systems are adding new capabilities, such as workflow support and knowledge management features.

Linkage to CC framework

Kind of tool	Organization tool **ICT tool**
Tool class/Underlying concept	**Document Management**
Support level	**Individual** **Team** **Organization**
Support of knowledge processes	**Creating** **Locating & Capturing** **Sharing & transferring** Applying
Support of network lifecycle	Network building **Network performance** Network rebuilding/regression
Support of knowledge objects	**Explicit knowledge** Implicit knowledge

Product examples	WWW-Address
Lotus Domino.doc	www.lotus.com
Documentum EDM Server/4i	www.documentum.com
PCDOCS DOCSOpen and DOCSFusion	www.pcdocs.com
Novasoft Novation	www.novasoft.com
FileNet Panagon	www.filenet.com
Opentext Livelink	www.opentext.com
Standardization	
Document Management Alliance (DMA)	www.aiim.org/dma/index.html

4.3.8 Organizational Thesaurus and Dictionary

The organizational thesaurus and dictionary is one tool within the tool class 'language tool'. The organizational thesaurus and dictionary is a manual of clearly defined and shared set of terms and ideas existing in organizations [see Ruggles 1997; also see concerning the following information on organizational thesaurus and dictionary). Without such a thesaurus and dictionary, different implicit definitions of the same term may lead to misunderstandings and false interpretations. Therefore, such a tool can clarify meanings of contexts and expressions and can set standards for using certain terms in an organization.

Implementing the organizational thesaurus and dictionary throughout a company is a move towards clarity within an organization. Because knowledge is so contextually rich, clarifying the shared contexts through a thesaurus or dictionary helps people see opportunities for new knowledge and helps to share and transfer existing knowledge more easily. Also, by structuring knowledge, it might be quite easy to find a place where specific lessons can be learned, and to figure out where to go to find information about a particular praxis area.

The organizational thesaurus and dictionary is developed by putting together terms and ideas and by finding a clear definition for them to serve as a standard. These standards may evolve over time and be added to the dictionary after a while. Therefore, the organizational thesaurus and dictionary is not rigid and grows over time. Finally, it is important to mention that just the exercise of deciding on term definitions, which some might take for granted, can spark a lively discussion as various perspectives are reconciled.

Linkage to CC framework

Kind of tool	**Organization tool** ICT tool
Tool class/Underlying concept	**Language tool**
Support level	**Individual** **Team** **Organization**
Support of knowledge processes	Creating **Locating & Capturing** **Sharing & Transferring** Applying
Support of network lifecycle	**Network building** **Network performance** Network rebuilding/regression
Support of knowledge objects	**Explicit knowledge** Implicit knowledge

Monetary incentives	Yes **No**
Short-term applicable	**Yes** No
Long-term applicable	**Yes** No
Short-term effective	**Yes** No
Long-term effective	**Yes** No

4.3.9 Coffee corners/talk rooms

Despite the commonly held opinion that employees standing in coffee corners waste corporate time, conversations often develop that are of great use to the respective company [see Davenport/Prusak 1998; the following comments are also based on this source]. Among others, reasons for potential benefits are:

- Conversation in coffee corners/talk rooms normally includes topics of daily business and the information resulting from such conversations can help to perform better in daily business
- Such conversations are unstructured and unforced occasions to exchange information. Therefore, people feel free to communicate about things that are going on and which seem important for them
- People bounce ideas off one another
- The exchanged information is often quickly and easily obtainable at such occasions and the conversation partners can often provide advice on how to solve certain addressed issues and problems
- It is a natural way to talk through problems and to share ideas

Companies increasingly understand that it is important to provide occasions, where people can exchange knowledge easily and in an unstructured and informal way. An example of a company that is seeking to enhance such knowledge exchange and knowledge creation is the Japanese company Dai-Ichi Pharmaceuticals. For this purpose, it built ‘green tea rooms’, a Japanese equivalent to western coffee corners. The company expects that researchers will visit the rooms for about twenty minutes per day, during their work time, and that they will have conversations about their current work with whomever they find. However, discussions or meetings in this tea room will never be organized.

Linkage to CC framework

Kind of tool	**Organization tool** ICT tool
Tool class/Underlying concept	**Communication tool**
Support level	**Individual** **Team** **Organization**
Support of knowledge processes	**Creating** Locating & Capturing **Sharing & Transferring** Applying
Support of network lifecycle	**Network building** **Network performance** **Network rebuilding/regression**
Support of knowledge objects	**Explicit knowledge** **Implicit knowledge**

Monetary incentives	Yes **No**
Short-term applicable	**Yes** No
Long-term applicable	**Yes** No
Short-term effective	**Yes** No
Long-term effective	**Yes** No

4.3.10 Job rotation

Job rotation can be defined as the planned movement of people from one job to another for the purpose of training and development [Douglas/Klein/Hunt 1985, p. 615]. This tends to broaden people's skills and flexibility. Through the advantages of seeing different parts of the company and performing different jobs, people can be motivated to participate in such job rotation programs [Carrell/Elbert/Hatfield 1995]. According to Hilb [1994], there are different possibilities to achieve a job rotation:

- rotating between functions like R&D, marketing etc.
- rotating geographically, i.e., working in different countries
- unilaterally or bilaterally
- internally or externally
- from and to customers, suppliers, etc.

By accumulating experience from different jobs, involved people can gain knowledge and experience in a variety of assignments [see also Douglas/Klein/Hunt 1985]. Another central advantage to an organization, is that the person can accumulate the different experiences and transfer the experience made to his or her daily work. Finally, persons involved in job rotation can, consciously or not, transfer knowledge throughout the organization.

Linkage to CC framework

Kind of tool	**Organization tool** ICT tool
Tool class/Underlying concept	**HMR tools**
Support level	**Individual** **Team** **Organization**
Support of knowledge processes	**Creating** Locating & Capturing **Sharing & Transferring** **Applying**
Support of network lifecycle	Network building **Network performance** Network rebuilding/regression
Support of knowledge objects	**Explicit knowledge** **Implicit knowledge**

Monetary incentives	Yes **No**
Short-term applicable	**Yes** No
Long-term applicable	**Yes** No
Short-term effective	**Yes** No
Long-term effective	**Yes** No

4.4 Knowledge Process 'Creation'

4.4.1 Groupware

Groupware is a general class of software products that facilitates communication, coordination and collaboration among people [Lotus Development Corporation 1996]. Groupware is designed to improve the productivity of work groups. It allows work groups – groups of people who need to interact with one another within an organization – to communicate and share information, even when they are working together at a distance or trying to coordinate activities asynchronously (working together 'any time - any space').

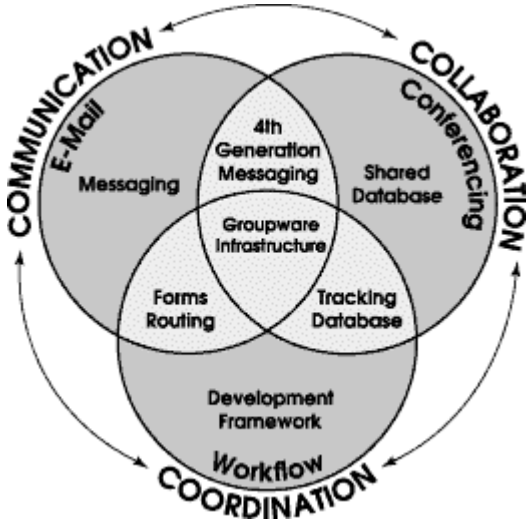

Figure 12: Groupware model - communication, collaboration, and coordination

The tool class Groupware is corresponding with the academic research field of Computer Supported Cooperative Work (CSCW). The software label 'Groupware' contains many subclasses of tools which can be asynchronous as well as synchronous technologies. Examples for groupware technologies are e-mail, video conferencing, chat, discussion databases, document databases, scheduling, workflow management systems, decision support systems, group editing systems, hypertext systems, and so forth.

In its origin, the technology was made possible by the growth and widespread use of electronic networks. The word 'Groupware' was first coined by Lotus to position Lotus Notes, which is the most visible example of a 'Groupware Suite', since this type of tool integrates different groupware applications into one product.

With the growth of the Internet as a global network, the potential for groupware has increased. Today, the capabilities of groupware environments leverage the open standards and features of the Internet and the WWW, including TCP/IP, HTTP, and HTML. This predestines groupware to play a central role as a collaborative platform within the enterprise's

intranet. As a result of the current developments, groupware and intranet are increasingly merging.

With regard to knowledge management, it can be stated that groupware vendors like Lotus or Microsoft have started to consider the needs of knowledge management in the development of their products. Furthermore, a huge market of third-party products exists, which - like the Lotus Notes Add-On GrapeVINE (www.grapevine.com) - can be used to enhance the capabilities of groupware in combination with knowledge management or other capabilities.

Linkage to CC framework

Kind of tool	Organization tool **ICT tool**
Tool class/Underlying concept	**Groupware**
Support level	Individual **Team** **Organization**
Support of knowledge processes	**Creating** **Locating & Capturing** **Sharing & transferring** Applying
Support of network lifecycle	**Network building** **Network performance** Network rebuilding/regression
Support of knowledge objects	**Explicit knowledge** **Implicit knowledge**

Product examples	WWW-Address
Lotus Notes/Domino	www.lotus.com
Microsoft Exchange	www.microsoft.com
Novell Groupwise	www.novell.com
Netscape SuiteSpot	www.netscape.com
SoftArc FirstClass	www.softarc.com
Teamware	www.teamware.com

4.4.2 Community tools

Community tools can be characterized as a class of tools that supports different types of online communities, also called virtual communities.

Virtual communities are one of the underlying ideas and concepts for this category of tools. Howard Rheingold, author of *The Virtual Community: Homesteading on the Electronic Frontier*, defines virtual communities as: “the social aggregations that emerge from the Net when enough people carry on those public discussions long enough, with sufficient human feeling, to form webs of personal relationships in cyberspace.” [Rheingold 1993] Another definition describes virtual communities as follows: “Social relationships forged in cyberspace through repeated contact within a specified boundary or place (i.e., a conference or chat line) that is symbolically delineated by topic of interest." [Fernback/Thompson 1995] Virtual communities still have many more characteristics which cannot all be described in this paper.

Originally, the virtual communities of the internet were primarily socially oriented communities. Later on, with the commercialization of the internet, virtual communities were discovered to be a useful concept for commercial purposes, for example, electronic commerce or customer relationship management (CRM).

From the tool perspective, it is important to recognize that the critical success factors in building and sustaining a virtual community are not primarily defined by the deployed community tool. Rather, other factors are central, which tend to depend heavily on the individual members of the virtual community.

The tools, which provide for community functionality can be quite different from each other, since they offer such different functions as discussion databases, (moderated) chat, mailing lists, instant messaging, push technology, and other collaborative technologies. The main focus of community tools is the support of communication. Some highly sophisticated tools also deliver 3-dimensional multimedia and virtual reality features, such as the possibility for users to create their own online-identity with so called ‘avatars’.

In more business driven applications, virtual communities are quite often used as part of a certain business model, for example, when they seek to bring more traffic to a company’s web site. Newer community tool approaches also try to combine community elements with the concept of so called portal sites.

With regard to knowledge networks, it can be stated that community tools are not originally made for the purposes of knowledge management. Many features which are needed for knowledge management and especially for knowledge networks are not provided by community software. Nevertheless, community tools can be combined with other tools or, for example, a knowledge base to enrich knowledge management platforms with community functionality.

Linkage to CC framework

Kind of tool	Organization tool **ICT tool**
Tool class/Underlying concept	**Community Tool/Virtual Community**
Support level	Individual **Team** **Organization**
Support of knowledge processes	**Creating** Locating & Capturing **Sharing & transferring** Applying
Support of network lifecycle	**Network building** **Network performance** Network rebuilding/regression
Support of knowledge objects	**Explicit knowledge** **Implicit knowledge**

Product examples	WWW-Address
O'Reilly Webboard	www.webboard.com
EShare Expressions Interaction Suite	www.eshare.com
Blaxxun Community Server	www.blaxxun.com
CommunityWare/XML™	www.webb.net
ICQ	www.icq.com

4.4.3 Data warehousing/Business intelligence

Data warehousing and business intelligence applications are essential elements of decision support, which has increasingly become a focus of the database industry. The topic of data warehousing is, similar to knowledge management, rather complex. Many commercial products and services are available and all of the principal database management system vendors have offerings in these areas. Compared to the traditional on-line transaction processing applications (OLTP), the data warehousing/business intelligence approach of decision support, places quite different requirements on database technology

Data warehousing can be defined as a collection of **decision support technologies**, aimed at enabling the knowledge worker (executive, manager, analyst) to make better and faster decisions [Chaudhuri/Umeshwar 1997]. The primary concept of data warehousing is that the

data stored for business analysis can be most effectively accessed by separating it from the data in the operational systems [Gupta 1997]. This implicates, that according to the data warehousing/business intelligence approach, data has to be gathered from different sources – using internal systems as well as external sources - and then has to be stored in a special database which is called 'data warehouse'.

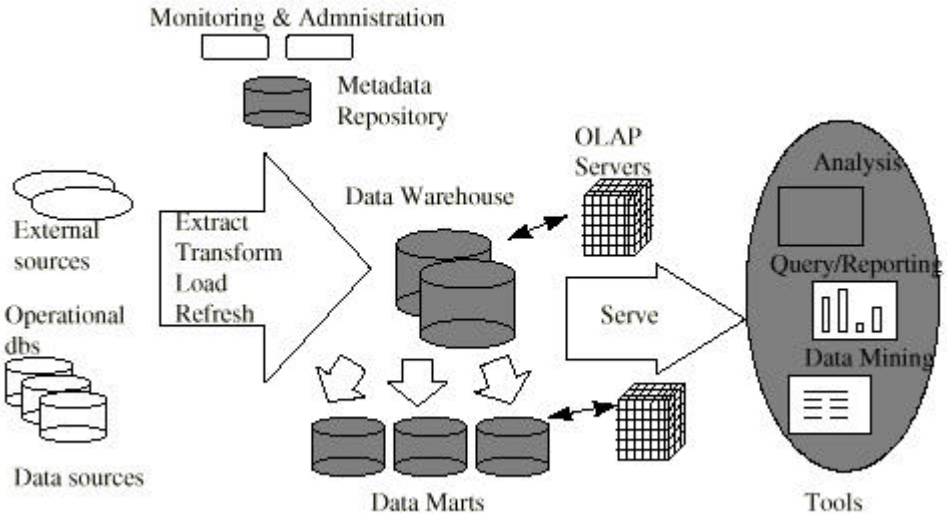

Figure 13: Data Warehousing Architecture [Chaudhuri/Umeshwar 1997]

Several approaches exist in the field of data warehousing that range from simple to complex. The two major approaches are the **data mart approach** and the **enterprise data warehouse**. These approaches differ in scale and complexity, but they can also be used in combination.

In general, the process to build a data warehouse is rather complicated. One reason for this is, that building a data warehouse requires an enterprise-wide data model which serves as a foundation of a data warehouse. To facilitate complex analyses and visualization, the data in a data warehouse is typically modeled multi-dimensionally [Chaudhuri/Umeshwar 1997]. The ensuing, complex process of data warehouse generation is comprised of a number of steps, including preparing, consolidating, cleansing, converting, translating, aggregating, and loading the data. The steps from designing to generating a data warehouse are supported with appropriate tools. Once a data warehouse is implemented, its data has to be prepared by an OLAP server, and can then be accessed and analyzed with appropriate front-end tools. When regarding those front-end tools for setting up a data warehouse, several subclasses of different tools can be distinguished, for example, online analytical processing tools (OLAP), reporting tools, data mining tools, decision support systems, management or executive information systems.

When one compares knowledge management with data warehousing, it becomes obvious that the two show a strong resemblance concerning various levels of analysis. This holds

true for the level of technological architecture, the level of application design, as well as for the strategic level that, in both cases, focuses on areas in which better information is likely to have the most beneficial impact on key business processes. A main divergence between the two concepts can be seen in their respective content: While data warehousing focuses more heavily on structured data and its analysis, knowledge management's content is less structured and more focused on people with their experience and their expertise. Hence, the knowledge management approach also includes implicit knowledge and can be characterized as more comprehensive and integrative than the data warehousing approach.
In combination with more collaborative technologies, data warehousing can play an important role for knowledge networks, for example, by supporting a knowledge network of analysts within the company.

Linkage to CC framework

Kind of tool	Organization tool **ICT tool**
Tool class/Underlying concept	**Data Warehousing**
Support level	**Individual** **Team** **Organization**
Support of knowledge processes	**Creating** **Locating & Capturing** **Sharing & transferring** Applying
Support of network lifecycle	Network building **Network performance** Network rebuilding/regression
Support of knowledge objects	**Explicit knowledge** Implicit knowledge

Product examples	WWW-Address
Integrated solutions	
IBM Visual Warehouse	www.ibm.com
NCR Teradata	www.ncr.com
Oracle 8	www.oracle.com
Platinum	www.platinum.com
SAS	www.sas.com
OLAP	
GentiaDB	www.gentia.com
Hyperion Essbase OLAP Server	www.hyperion.com
MicroStrategy Agent	www.microstrategy.com
Data Mining	
IBM IntelligentMiner	www.ibm.com
Pilot Discovery Server	www.pilotsw.com
Query and reporting	
Brio Technologies	www.brio.com
Seagate	www.seagatesoftware.com
Cognos	www.cognos.com
Business Objects	www.businessobjects.com

These are only a few selected tool classes and products in the extensive field of data warehousing. It is not the intention of this paper, to give a complete overview of data warehousing products and technologies.

4.4.4 Knowledge activists

The knowledge activist belongs to the tool class ‘knowledge role’. In recent years, the role of the knowledge activist has been widely discussed. A knowledge activist can be defined as a person taking the responsibility for energizing and coordinating knowledge creation efforts throughout the company [based – as well as all other information regarding knowledge activists – on von Krogh/Nonaka/Ichijo 1997]. This role can be taken by individuals, groups or departments. For example, a corporate knowledge and technology transfer unit might take the position of a knowledge activist.

Regarding roles and tasks knowledge activists have to take, three roles seem to be appropriate for them; as a catalyst of knowledge creation, as a connector of knowledge creation initiatives and as a merchant of foresight (see table 9):

Role as	**tasks**
a **catalyst of knowledge creation**	• formulating process triggers • creating space and context for knowledge creation
a **connector of knowledge creation initiatives**	• establishing imagined communities
a **merchant of foresight**	• providing overall direction to the knowledge creation taking place in different places/networks

Table 9: Roles of a knowledge activists and correlating tasks

Hereby, a knowledge activist doesn't control, but merely enables knowledge creation. Also, he or she should not only connect others, but rather further self-motivated connections.

Linkage to CC framework

Kind of tool	**Organization tool** ICT tool
Tool class/Underlying concept	**Knowledge role tool**
Support level	**Individual** **Team** **Organization**
Support of knowledge processes	**Creating** Locating & Capturing **Sharing & Transferring** **Applying**
Support of network lifecycle	**Network building** **Network performance** **Network rebuilding/regression**
Support of knowledge objects	**Explicit knowledge** Implicit knowledge

Monetary incentives	Yes **No**
Short-term applicable	**Yes** No
Long-term applicable	**Yes** No
Short-term effective	**Yes** No
Long-term effective	**Yes** No

4.4.5 Scenario and scenario learning

Scenario and scenario learning is a tool, which belongs to the tool class 'creativity tools'. Scenarios are descriptive narratives of projections of a potential future [this definition and the following information on scenarios and scenario learning is based on Fahey/Randall 1998]. By combining those events that have fairly predictable future outcomes with those that are not predictable, it becomes possible to conceive a wide assortment of futures.

Scenario learning means combining scenario development and decision making processes. It helps people:

- to combine what they know and what they can imagine, into logical stories about the future
- to consider implications for their activities and their choices and to reframe existing decisions
- to extend their horizon
- to create new, unconventional knowledge

Scenarios exist of different elements. No matter which specific scenarios one uses, the following elements are most common to different scenario approaches:

- driving Forces: forces like environmental forces and actions of institutions supporting a specific plot
- logic: the explanations or rationales for the content of the plot
- plot of the story: what must happen in order for the scenario's end state to arrive
- end state: the conditions and circumstances that prevail at the end of the scenario plot to create new, unconventional knowledge

Regarding basic scenario approaches, scenario construction may be segmented into two basis approaches:

- future backward: select several significant futures and try to discover the paths that lead to them
- future forward: project sets of plausible futures based on analysis of present forces and their likely evolution

Certainly, if the distinction can't be made in this basic fashion, a variety of scenario approaches and techniques may be specified (see table 10):

Examples of Scenario Approaches/Techniques
Scenario Matrix
Mental maps of the Future
Future mapping
Dynamic Scenarios
Simulation models

Table 10: Examples of Scenario Approaches/Techniques

Linkage to CC framework

Kind of tool	**Organization tool** ICT tool
Tool class/Underlying concept	**Creativity tool**
Support level	Individual **Team** **Organization**
Support of knowledge processes	**Creating** Locating & Capturing Sharing & Transferring Applying
Support of network lifecycle	**Network building** **Network performance** **Network rebuilding/regression**
Support of knowledge objects	**Explicit knowledge** **Implicit knowledge**

Monetary incentives	Yes **No**
Short-term applicable	**Yes** No
Long-term applicable	**Yes** No
Short-term effective	Yes **No**
Long-term effective	**Yes** No

4.4.6 Creativity techniques

Creativity techniques have received much attention in recent years. Creativity techniques, are techniques, which tend to improve the individual or group creativity [http://www.ozemail.com.au/~caveman/Creative/Techniques/index.html; the following information and examples are also based on this internet page[2]]. Therefore, creativity can be understood as the ability to take existing objects and combine them in different ways and for new purposes, generating new and useful ideas and solutions to everyday problems and challenges. Creativity can be an important factor for knowledge creation.

[2] On the mentioned internet page, readers will find a lot of useful information about creativity as well as detailed descriptions of the creativity techniques mentioned above.

Quite a large range of creativity techniques exists. In the following table 11, many of them are listed:

Examples of Creativity Techniques
Random Input
Problem Reversal
Ask Questions
Applied Imagination – Question Summary
Lateral Thinking
Six Thinking Hats
The Discontinuity Principle
Checklists
Brainstorming
Forced Relationships/Analogy
Attribute Listing
Morphological Analysis
Imitation
Mindmapping
Storyboarding
Synectics
Metaphorical thinking
Lotus Blossum Technique
In the realm of the senses
Use of drawing
IdeaToons
NLP (Neuro-Linguistic Programming) Techniques
Assumption Smashing
DO IT!
LARC Method
Unconscious Problem Solving
Simplex
The TRIZ method
Fuzzy Thinking
Breakthrough Thinking

Table 11: Examples of Creativity Techniques

Considering the overwhelming amount of available creativity techniques, one technique – which seems to be quite interesting and which is not as well known as techniques like brainstorming or synectics - is selected as an example and will be described in the following. This example is the “discontinuity principle”.

Discontinuity principle: the more people are used to something, the less stimulating it is for their thinking. A way to get out of conventional thinking is to disrupt existent thought patterns. This is achieved by presenting those ideas to people, which force them to make new connections in order to comprehend the situation. Therefore, it makes sense to program interruptions into the day, to change working hours, to work a different way, to listen to a different radio station, to read some magazines or books one wouldn't normally read, to try a different recipe, to watch a TV program or film one wouldn't normally watch and so on. Contradictory ideas should exist next to each other, so that the dissonance between the two forces new thought paths (a technique that already flourishes in the east with, for example, haiku poetry and Zen koans).

Linkage to CC framework

Kind of tool	**Organization tool** ICT tool
Tool class/Underlying concept	**Creativity tool**
Support level	**Individual** **Team** **Organization**
Support of knowledge processes	**Creating** Locating & Capturing Sharing & Transferring **Applying**
Support of network lifecycle	**Network building** **Network performance** Network rebuilding/regression
Support of knowledge objects	**Explicit knowledge** **Implicit knowledge**

Monetary incentives	Yes **No**
Short-term applicable	**Yes** No
Long-term applicable	**Yes** No
Short-term effective	**Yes** No
Long-term effective	**Yes** No

4.4.7 Metaphors

Metaphors are one tool of the language tools, besides dialog, storytelling, common language, controlled vocabulary, and organizational thesaurus and dictionary. Metaphors have been used for a very long time (already Aristotle thought of them). Recently, metaphors have received attention in the knowledge management literature by the work of Nonaka [see for example Nonaka 1991]. Metaphors can be defined as paraphrases (mostly figurative ones) of things and situations [this definition and the following information concerning metaphors is based on Nonaka 1991, Bolman/Deal, and http://www.compapp.dcu.ie/~tonyv/trinity/lakoff.-html]. It is a way of expressing, understanding and experiencing one kind of thing in terms of another. Therefore, it is not just a grammatical structure or an allegorical expression, but more a method of perception. It is a way for individuals to understand something intuitively through the use of imagination and symbols, without the need for analysis or generalization. By using metaphors, which can have multiple meanings, certain aspects of experiences are highlighted and others are obscured.

Through metaphors, people can also:

- express what they know but cannot say; which means finding a way to express the inexpressible
- communicate what is too complicated to express
- what – directly expressed – would be too obstructing

By applying metaphors, people can set up a discrepancy and/or a surprise by merging two different and distant areas of experience into a single, inclusive image or symbol and thereby forging a connection between two things that seem only distantly related. Attempts to think of such a discrepancy, to reconcile conflicting meanings, and to adapt conceptual models to accommodate to a new view lead to a creative process. According to Lakoff, metaphors fa-

cilitate thought by providing an experimental framework into which newly acquired, abstract concepts may be accommodated. Thereby, metaphors help to reorganize conceptual models by reclassifying concepts under new categories.

Linkage to CC framework

Kind of tool	**Organization tool** ICT tool
Tool class/Underlying concept	**Language tool**
Support level	**Individual** **Team** Organization
Support of knowledge processes	**Creating** **Locating & Capturing** **Sharing & Transferring** Applying
Support of network lifecycle	**Network building** Network performance Network rebuilding/regression
Support of knowledge objects	Explicit knowledge **Implicit knowledge**

Monetary incentives	Yes **No**
Short-term applicable	**Yes** No
Long-term applicable	**Yes** No
Short-term effective	**Yes** No
Long-term effective	**Yes** No

4.5 Knowledge Process 'Applying'

4.5.1 Visualization tools

Presenting information in visual form is an increasingly common way of working with computers in a wide range of knowledge work. There are many different types of tools which fall into this category. Since the visualization of knowledge helps in applying knowledge, the tool class 'visualization tools' is listed under the knowledge process 'applying'. Visualization tools also exist, which primarily focus on creating new knowledge or – like knowledge maps - on knowledge capturing (see 3.3).

In the field of 'data warehousing/business intelligence', tools can be found for the **visualization and exploration of data**, such as data mining tools, which provide an intuitive multidimensional view of the data resulting from multidimensional operations and also show connections between different elements of information. The same can be stated for text mining tools, which provide functionalities to visualize relations between different documents or terms, and so forth.

Three-dimensional visualization is used extensively in simulations [Skyrme 1999]. In many industries, so called **geographical information systems** (GIS) are used as a powerful tool for the analysis and presentation of spatial and geographical data.

Another type of visualization tool is represented with **knowledge mapping tools** (also see 4.2.4). Knowledge maps are graphical representations of knowledge, knowledge carriers, knowledge structures, knowledge stages of development or knowledge applications. Knowledge maps can be used as a guide for available knowledge in the company [Schoen/Seiler 1998].

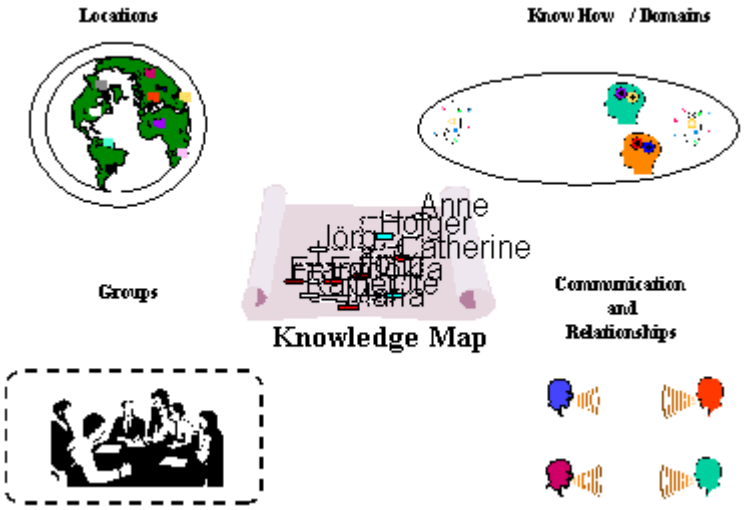

Figure 14: Knowledge map

The user of the knowledge map can, to mention an example, assign the worldwide distributed locations to the employees working at a respective location. Further, one can see the know-how of the employees or, for example, the processes they currently work on. In the case of concluded projects, one can also see, whether solutions have already been found. One can also visualize groups with their individual members [Schoen/Seiler 1998].

A well-known tool which is used in several applications is **Inxight's hyperbolic tree** developed at Xerox. With this visualization technology the concept of interest is placed centrally on the screen, showing links to other concepts, presenting the strongest and nearest links close to the center, with the more remote ones showing in less detail. The viewer can drag on one of these, if he or she wishes to bring it into closer detail [Skyrme 1999].

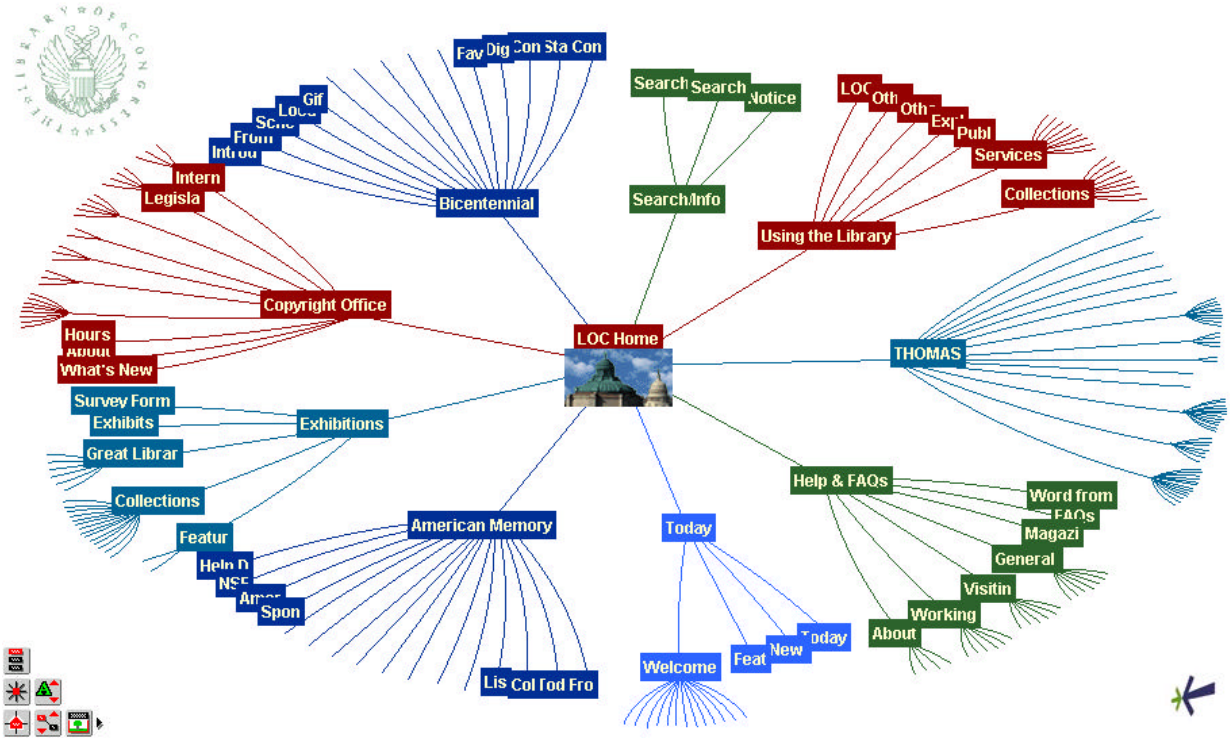

Figure 15: Hyperbolic tree view [Inxight 1999]

To organize and visualize ideas and projects, to simplify problem-solving, to structure problems, to develop simple knowledge maps, and so forth, the tool-based **Mind Mapping method** (originated by Tony Buzan) is another popular visualization and creativity tool (www.mindman.com).

Linkage to CC framework

Kind of tool	Organization tool **ICT tool**
Tool class/Underlying concept	**Visualization tools**
Support level	**Individual** Team Organization
Support of knowledge processes	**Creating** Locating & Capturing **Sharing & transferring** **Applying**
Support of network lifecycle	Network building **Network performance** Network rebuilding/regression
Support of knowledge objects	**Explicit knowledge** **Implicit knowledge**

Product examples	WWW-Address
MindManager	www.mindman.com
Hyperbolic Tree	www.inxight.com
The Brain	www.thebrain.com

4.5.2 Learning platforms

Learning platforms can be defined as a class of ICT tools that supports the concept of **Computer based learning (CBL)**. Computer based learning is an environment where learning activities are performed with a computer and where software takes a central and important role. There are many different forms of CBL, ranging from simple information search and retrieval (i.e., web research), to mediated instruction (where the computer/software instruct you and assess your performance, even modifying the instruction stream). Depending on the software used, CBL can be relatively passive (such as reading on-line documents) or quite interactive.

Some of the main advantages of CBL are the following:

Self-paced learning: The individual user is able to proceed through the learning materials at their own pace. He or she can back up, skip forward, or repeat segments of a lesson according to his or her own needs. The user controls the pace of delivery.

Asynchronous delivery: The user is able to choose when and where they will perform the learning activity.

Distance learning: Learning activities are not restricted to a specific location like a lecture room, a campus, a city, or even a country.

Multimedia: Modern software and computer platforms are able to present information in a variety of ways. This allows people with different learning styles to see new information in many different forms.

Some of the main disadvantages of CBL are the following:

Learning motivation: Because the onus for learning is shifted onto the learner, each user must be motivated to complete the computer based activities on their own. There is no instructor/lecturer setting the schedule. Empirical evidence shows, not surprisingly, that learning performance is directly correlated with the learners motivation and effort.

Generality: CBL cannot replace a human teacher entirely. It is just too difficult to try to foresee all questions or problems that a learner may have and write the CBL materials accordingly. One-to-one communication between a teacher and a student is, and probably always will be, necessary to resolve many questions.

Resource requirements: Obviously, in order to access CBL, the learner needs computer technology. Modern CBL software – which also may include resource-intensive realtime technology (i.e., audio/video) - places high requirements on the type and capability of computer hardware. In addition, the multiplicity of hardware and operating platforms makes it difficult to implement CBL software in such a way that enables it to run anywhere. Standards and minimal hardware requirements are necessary.

Linkage to CC framework

Kind of tool	Organization tool **ICT tool**
Tool class/Underlying concept	**Learning platforms**
Support level	**Individual** Team Organization
Support of knowledge processes	Creating Locating & Capturing **Sharing & transferring** **Applying**
Support of network lifecycle	Network building **Network performance** Network rebuilding/regression
Support of knowledge objects	**Explicit knowledge** Implicit knowledge

Product examples	WWW-Address
Lotus LearningSpace	www.lotus.com
FirstClass	www.softarc.com
Authorware	www.macromedia.com
Coursebuilder for Dreamweaver	www.macromedia.com
Asymetrix Toolbook	www.asymetrix.com
Pinnacle Learning Manager	www.courseware.com

4.6 Integration of Knowledge Processes

4.6.1 Intranet

The term ‘intranet’ signifies the implementation of open and standardized internet technologies for computer networks within an enterprise. Such an intranet is characterized by the following, central attributes:

- It is an enterprise-internal computer network that offers the ability to integrate the isolated partial networks existent in the enterprise and to which only employees of the enterprise have access
- It is based on the standardized internet communication protocol TCP/IP
- It allows the building of new architectures that extend beyond the traditional client-server model

Regarding the definition of an intranet, it becomes clear, that an intranet is not a tool but rather a platform to implement as many functionalities as desired [Thiesse/Bach 1999]. To realize those functions, an intranet provides several basic technologies and services.

The most well-known technology, respectively basic service, of the internet and – according to its definition - also of an Intranet is the World Wide Web technology. This basic service can be described as a (globally) distributed client-server application that is based on the principle of hypertext. In the World Wide Web, hypertext documents are stored on servers (web servers) that can be accessed from client computers only by means of a web browser. A main advantage of the intranet is that, since its technologies are platform-independent, the web browser can be used as single, standardized user-interface on client-side.

Underlying technologies that make the WWW work, are in particular the transmission protocol HTTP and the document format HTML. Another important feature of the WWW technology is that multimedia information (pictures, sound, video) can be integrated into web documents.

Other technologies of an intranet - which among others are important to develop intranet applications - are programming languages like Java, script languages and other integration mechanisms like CGI, ASP, or - with increasing importance - XML.

When we look at today’s intranets, we usually find a number of typical applications or services, like the following: e-mail, discussion and/or chat forums, search engines, search catalogues, yellow pages, document management, push technology. Since software vendors today for the most part offer web-enabled versions of their products, intranet can be designated as the ideal platform to integrate applications, data, information and knowledge.

With regard to the support of knowledge networks with appropriate ICT, it can be said that intranet, with its co-related technologies and standard applications (i.e., newsgroups), provides a lot more possibilities than sophisticated groupware applications have to offer. Since

today many companies already have built their own intranet, its related technologies will often play a central, integrative role within a tool architecture for knowledge networks. As a matter of course, an intranet taken by itself can neither be the perfect solution for knowledge management nor for knowledge networks. The short history of intranets shows, that typical knowledge management problems, such as information overload or search problems, within intranets and the worldwide internet are much the same. Currently, new knowledge management tools are arriving, which promise to solve those problems.

Linkage to CC framework

Kind of tool	Organization tool **ICT tool**
Tool class/Underlying concept	**Intranet**
Support level	**Individual** **Team** **Organization**
Support of knowledge processes	**Creating** **Locating & Capturing** **Sharing & transferring** **Applying**
Support of network lifecycle	**Network building** (when using typical intranet applications like e-mail, newsgroups, etc.) **Network performance** Network rebuilding/regression
Support of knowledge objects	**Explicit knowledge** **Implicit knowledge** (e.g. with yellow pages that serve as 'pointers to expertise')

Product examples	WWW-Address
Web servers	
Microsoft Internet Information Server	www.microsoft.com
Apache Server	www.apache.org
Netscape Enterprise Server	www.netscape.com
Domino Web Server	www.lotus.com
Web browsers	
Microsoft Internet Explorer	www.microsoft.com
Netscape Communicator	www.netscape.com
Other technologies	
Java	www.sun.com
ActiveX	www.microsoft.com
Javascript	www.netscape.com
XML	www.xml.com
Standardization of technologies	
Internet Engineering Task Force (IETF)	www.ietf.org
Internet Society (ISOC)	www.isoc.org
Internet Architecture Board (IAB)	www.iab.org
Internet Research Task Force (IRTF)	www.irtf.org
World Wide Web Consortium (W3C)	www.w3c.org

There are still many more products and technologies (i.e, mail servers, application servers, ftp servers, proxy servers), which are important to build an intranet. It is certainly not the intention of this working paper to give a complete overview of them.

4.6.2 Enterprise portals

An enterprise portal provides business users with a single web interface to corporate and/or externally stored information. Another important attribute of such a portal is, that the delivery of information and/or applications is based on user profiles/roles and takes place in a personalized manner.

IDC identifies portals as the ideal medium for knowledge management and concludes that one single type of portal – so called Enterprise Information Portals (EIP) - are currently not sufficient for the corporate world. IDC identifies four points of necessary evolution for corporate portals:

- **Enterprise information portals (EIP),** which provide personalized information to users on a subscription and query basis
- **Enterprise collaborative portals (ECP)**, which provide virtual places for people to work together
- **Enterprise expertise portals (EEP)**, which provide connections between people based on their abilities
- **Enterprise knowledge portals (EKP)**, which provide all of the above and proactively deliver links, in real time, regarding content and people that are relevant to what users are working on [IDC 1999]

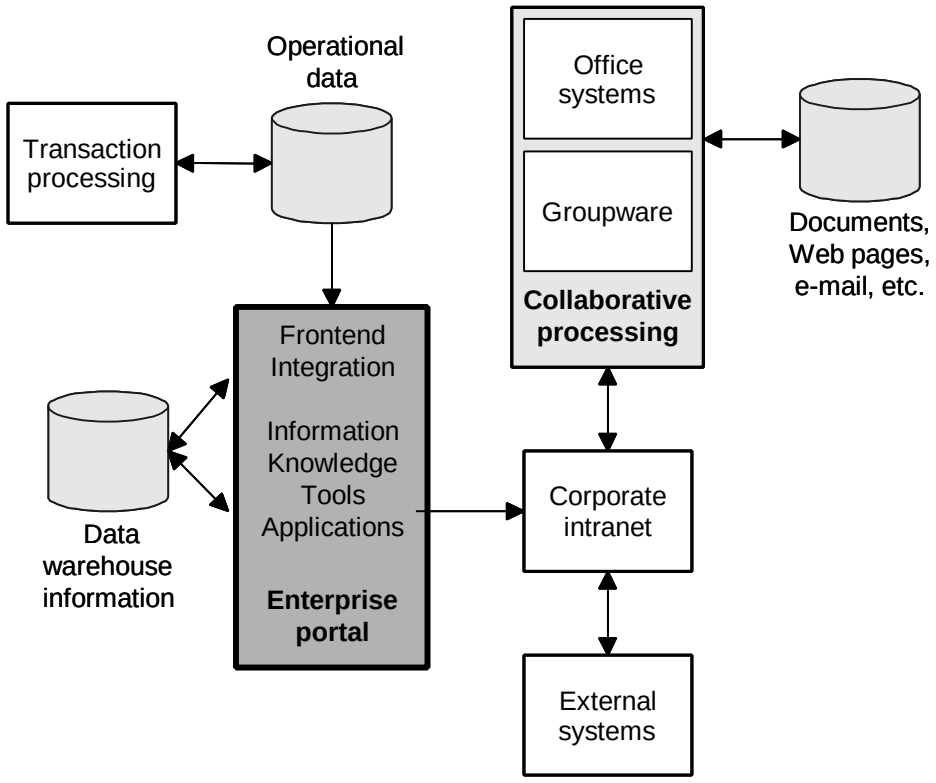

Figure 16: Enterprise portal

The origin of the portal concept can be traced to public information providers like Yahoo (www.yahoo.com). This kind of portal is called **public portal, internet portal, web portal** or **horizontal portal**. Another type of portal is called **vertical portal**, which are portals with a tightly focused content area geared towards a particular audience [Lynch 1998]. For example, this can be an industry-related portal that focuses on limited virtual market places.

Since, more than one portal often exists within an organization, another type of portal might be of interest: a **meta portal** integrates different portals to a single, web browser-based gateway for user access (e.g. http://www.portal-select.com/portal-select/reviews.htm).
One of the main principals behind the concept of portals can be designated as 'frontend integration'. Frontend integration of information and applications via a single web browser interface, combined with personalization features, were soon recognized as useful for the purposes of knowledge management. Some KM software products already offer portal functionality. For the tool support of knowledge networks, the enterprise portal concept also seems to be a promising approach.

Linkage to CC framework

Kind of tool	Organization tool **ICT tool**
Tool class/Underlying concept	**Enterprise Portal**
Support level	**Individual** **Team** **Organization**
Support of knowledge processes	Creating **Locating & Capturing** **Sharing & transferring** **Applying**
Support of network lifecycle	Network building **Network performance** Network rebuilding/regression
Support of knowledge objects	**Explicit knowledge** Implicit knowledge

Product examples	WWW-Address
Plumtree Corporate Portal	www.plumtree.com
DataChannel RIO Portal Server	www.datachannel.com
Autonomy Portal in a box	www.autonomy.com
MySAP.com Workplace	www.sap.com
Semio Taxonomy	www.semio.com
Illuminar	www.verano.com
Knowledge Organizer	www.verity.com
PortalWare	www.glyphica.com
Freedom	www.infoimage.com
Viador E-Portal Suite	www.viador.com
Intraspect Knowledge Server	www.intraspect.com
TopTier Portal	www.toptier.com

4.6.3 Knowledge management suites

The term 'Knowledge Management Suite' should be used here to signify a class of ICT tools which try to cover all levels of knowledge management and the related tasks, processes and requirements. Following this definition, those tools can be used to store, retrieve, categorize and provide access to all types of (explicit) knowledge within a company. An example of the technical architecture of such a 'Knowledge Management Suite' shows the following figure:

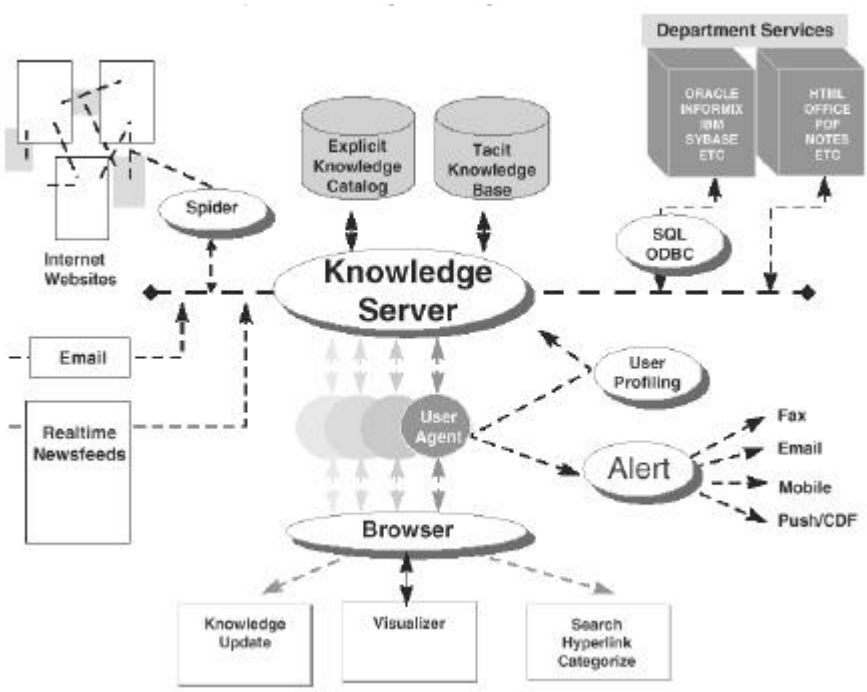

Figure 17: Autonomy's Knowledge Management Architecture

The landscape of tools with explicit knowledge management focus presents itself as being rather heterogenous. Since the field of knowledge management is quite a new topic, we find many new software products within this tool category that address knowledge management in a direct way. The vendors of knowledge management suites provide products that, for example, explicitly filter large volumes of online information, allowing users to add insights and opinions and to organize the information in meaningful ways, using ever more sophisticated algorithms to deduce meaning from the words and phrases of text documents. Some of those tools also allow it to create and manage knowledge taxonomies by creating links between information that might not otherwise seem related.

Other products within this category have been formerly labeled as document management systems and currently have been enhanced with additional knowledge management capabilities. Many other vendors (of intranet development environments, information retrieval engines, electronic publishing systems and other technologies) are also following the know-

ledge management trend, now presenting their products as knowledge management systems.

A closer look at the relevant products within this tool class shows, that there are great differences in the KM approaches of the different vendors. One product can hardly cover all knowledge management requirements [Paribas 1998]. Some products – like DOCSFulcrum - focus on locating and capturing knowledge. Other knowledge management suites - like Autonomy - are specialized in categorizing knowledge automatically. Some products include their own knowledge database or – in analogy to the data warehousing approach - also called 'knowledge warehouse' [Dataware 1997]. Others provide more or less easy access on existing knowledge storage, like databases, documents, etc., without storing them in a 'knowledge warehouse'. In most cases a repository to store meta-information about existing knowledge in existing knowledge sources can be built in order to add value to the existing information.

The vendor strategies also differ: Some vendors offer total functionality in one product or software bundle. Others only sell separate components (i.e., for searching, profiling, user notification, agents) which can be combined to a whole knowledge management suite.

Regarding the support of knowledge networks with such comprehensive knowledge management suites, it can be said, that today and in the future they often will build a main part of the architectural ICT background for knowledge management and networking activities within the enterprise. In addition, those tools might be enriched and completed with tools that focus more on collaborative functions in order to give a stronger support to the process of knowledge creation within knowledge networks.

Linkage to CC framework

Kind of tool	Organization tool **ICT tool**
Tool class/Underlying concept	**Knowledge Management Suite**
Support level	**Individual** **Team** **Organization**
Support of knowledge processes	Creating **Locating & Capturing** **Sharing & transferring** **Applying**
Support of network lifecycle	Network building **Network performance** Network rebuilding/regression
Support of knowledge objects	**Explicit knowledge** Implicit knowledge

Product examples	WWW-Address
Verity Knowledge Retrieval Product Suite	www.verity.com
DOCSFulcrum	www.pcdocs.com
Opentext Livelink	www.opentext.com
Autonomy's Knowledge Server	www.autonomy.com
Documentum	www.documentum.com
Dataware Knowledge Management Suite	www.dataware.com

4.6.4 Knowledge goals

Articulated knowledge goals help to give direction to different knowledge management tasks. By formulating knowledge goals, on the one hand, the importance of knowledge tasks is emphasized, on the other hand, it is ensured that knowledge tasks are performed in a more systematic and conscious way,.

Knowledge goals can be defined on different levels: on the normative level, the strategic level, as well as on the operational level [see - as well as for the following comments - Probst/Raub/Romhardt 1997]. The normative level is about defining a knowledge culture and setting up an environment that encourages knowledge management. These normative goals can result in a knowledge vision which has to be supported by top management. On the stra-

tegic level, questions like “Which knowledge will be important for the future and which is therefor necessary to develop?” or “ What kind of knowledge does already exist in the company and has to be leveraged in the company?” arise. Regarding knowledge goals on the operational level, the goal is to separate normative and strategic goals into sub-goals which can then be performed practically.

Knowledge goals have to go hand in hand with company goals. According to the Competence Center thinking, knowledge goals are intended to support the following business goals: to reduce risks, to increase efficiency, or to improve innovation. Also, it will be quite important that these knowledge goals can be measured.

When knowledge goals are being defined, some difficulties may arise [see again Probst/Raub/Romhardt 1997], such as a missing common language about knowledge, problems operationalizing or issues of strong, inflexible habits of power struggles.

Linkage to CC framework

Kind of tool	**Organization tool** ICT tool
Tool class/Underlying concept	**Knowledge vision/goal tool**
Support level	**Individual** **Team** **Organization**
Support of knowledge processes	**Creating** **Locating & Capturing** **Sharing & Transferring** **Applying**
Support of network lifecycle	**Network building** **Network performance** Network rebuilding/regression
Support of knowledge objects	**Explicit knowledge** Implicit knowledge

Monetary incentives	Yes **No**
Short-term applicable	**Yes** **No**
Long-term applicable	**Yes** No
Short-term effective	**Yes** **No**
Long-term effective	**Yes** No

4.6.5 Incentive systems

Incentive systems – as a one-time supplement - are designed to motivate people [see Cascio 1989]. Incentive systems thereby build on the fact that increased motivation improves performance and that recognition is a major factor for motivation. For incentives, a distinction between short-term incentives and long-term incentives regarding the period for measuring of performance can be made with short-term incentives measured for one year less and long-term incentives measured for more than one year [Ferris/Rosen/Barnum 1995].

Very often, incentives are financial ones which are based on fulfillment of job tasks and on personality [similar see Mergel 1999]. Forms of financial incentives are e.g.:

- Stock awards
- Cash payment.

But, incentives can also have a non-financial character. They can also have the following forms [see Mergel 1999 for parts of the following list]:

- Improved status symbols
- Opportunities for promotion
- Improved possibilities for participation in decision-making
- Events
- Extra vacation time

Regarding incentive systems, which should support knowledge management initiatives and knowledge work processes, incentives are critical. On the one hand incentives, which are related to knowledge activities such as knowledge locating and capturing, knowledge sharing/transferring, knowledge creating, and knowledge applying could help to build additional motivation to resolve the tasks in the company. On the other hand, incentives can be counterproductive if they encourage just short time thinking since knowledge management is not

just a short time issue. Moreover, many knowledge tasks as well as knowledge cultures are very often based on a long term perspective.

Linkage to CC framework

Kind of tool	**Organization tool** ICT tool
Tool class/Underlying concept	**Incentive systems**
Support level	**Individual** **Team** Organization
Support of knowledge processes	**Creating** **Locating & Capturing** **Sharing & Transferring** **Applying**
Support of network lifecycle	**Network building** **Network performance** **Network rebuilding/regression**
Support of knowledge objects	**Explicit knowledge** Implicit knowledge

Monetary incentives	**Yes** **No**
Short-term applicable	**Yes** **No**
Long-term applicable	**Yes** No
Short-term effective	**Yes** **No**
Long-term effective	**Yes** No

5 OUTLOOK

The differentiation of the tool classes described in this working paper follows a rather pragmatic approach. Many of the tool classes are derived from a common, underlying concept (i.e., data warehousing, groupware, intranet). Some of those underlying concepts are very broad (i.e., intranet), some are more narrow categories (i.e., summarization tools). In this working paper, those very different concepts, respectively tool classes, stand next to each other in a loosely coupled manner, since it was not the intention here to examine too deeply the relationship between the tool classes and their underlying concepts. For this reason, something like a comprehensive taxonomy of tools for knowledge networking was not intended to be a result of this paper.

Nevertheless, what has be done in this research work is, deepening the understanding of the tool layer of the CC framework and its potentials to support certain knowledge processes and also – according to the dynamic view on networks - the potentials to support the lifecycle of knowledge networks.

As a preparation step for the actual tool evaluation, some general considerations were made which are addressed in chapter 2. In order to reduce complexity, those considerations then lead to the further proceeding, which was to divide the expanded field of tools into different tool classes and - if possible - from them to derive sub classes.

A next step to prepare the actual tool collection and evaluation was, to develop a **criteria catalog** for the purpose of tool evaluation. This criteria catalog contains the sections **general criteria** and **specific criteria** for ICT tools as well as for organizational tools, **criteria for linkage with the CC framework** and **criteria for integration**. A last step of the foregoing considerations was, to suggest and define some action steps towards a tool collection. This point mainly refers to the undertaking we started in the Competence Center, to 'collect' and describe concrete tools/products and place those descriptions on the web platform of the Competence Center (http://www.knowledgesource.org).

Whereas for the task of the web-based tool collection the whole criteria catalog is needed, in this working paper we focused on classifying ICT tools and organizational tools according to the criteria of the CC framework (i.e., the knowledge work processes). For this, the in chapter 2 defined **criteria for linkage with the CC framework** were used.

A main goal of this paper was, to identify relevant ICT and organizational tool classes to support knowledge networks and to give an integrated overview of them. The integrated 'at a glance' overview of both types of tool categories is given in chapter 3 of this paper in the form of several 'tool maps'.

Further, it was the intention, to apply the defined criteria for linkage with the CC framework to the identified tool classes and tools. The result of this is also summarized in chapter 3, where

an overview of ICT- and organizational tools and their **potential to support the knowledge processes** is given.
Following, chapter 4 describes some of the tools and tool classes (but not all off them) and their possibilities in more in detail. For those tools, we not only estimated their support potential for knowledge processes, but also the **potentials of those tools to support the network lifecycle**. Further, the criteria for linkage with the CC framework were used, to make some statements about the **support-level of the tool classes** (individual, network, organization) and also the **support of knowledge objects** (explicit and/or implicit knowledge).
.
In contrast to other evaluation projects, which only deal either with ICT tools or with organizational tools, it was a further goal to describe both categories of tools within one working paper, not being divided into separate chapters. With such an approach we sought to underline, that both, ICT as well as organizational tools are necessary for the successful implementation of knowledge management. In contrast to this, the relation between ICT tools and organizational tools, is in practice very often unbalanced and not adjusted. Actually, they should be used in a well-balanced and coordinated way, because communication in knowledge networks must be supported with ICT- and organizational tools as well.

Part of the criteria catalog, but not further discussed in this working paper, is the subject of **integration of the different tool classes**. As the integration criteria in chapter 2 hint at, integration in general has to consider many aspects, such as technical integration, integration of knowledge processes, integration of support levels, integration of knowledge subjects, integration between organization and ICT. The subject of integration in particular becomes relevant, when different tools should be combined or even an integrated tool architecture should be built. **Integration** and **development of a knowledge network architecture model** are both considered to be important research topics for the further work of the Competence Center, seeking to further develop the tool layer of the CC framework.
Further to be considered in the research work is the interdependence of the tools, the combination of organizational and ICT tools to tool sets, the use of tools to support certain business goals, the configuration of an adequate tool architecture, respectively tool sets, that support business goals, network goals or specific knowledge processes.

Finally, it should be said that a company does not have to employ all tool classes mentioned in this working paper. Not all of them can be used together, at the same time, and at the same place. Rather, each company will decide on their own tool set consisting of certain tools. Corporate culture and organization have a strong influence on the specific tools chosen. Last but not least, financial aspects will always have to be taken into account.

6 APPENDIX

Sheet "Criterion catalog for ICT- and organizational tools to support knowledge networks"

For interested readers, the tables which are used in this paper to classify tools are listed here without any content in order to give the partners/readers the opportunity to use these sheet patterns for their own tool classification/evaluation.

Sheet "General Criteria for ICT tools"

General criteria
Product name
Current version/release
On the market since
Manufacturer
Number of installations
Reference customers
Platform requirements
Pricing

Sheet "Specific Criteria for ICT tools"

Specific criteria
According to tool/tool class and/or underlying concept
…
…
…
…
…

Sheet "Specific Criteria for Organizational tools"

Monetary incentives	Yes No
Short-term applicable	Yes No
Long-term applicable	Yes No
Short-term effective	Yes No
Long-term effective	Yes No

Sheet "Criteria for linkage with CC framework"

Kind of tool	Organization tool ICT tool
Tool class/Underlying concept	
Support level	Individual Team Organization
Support of knowledge processes	Creating Locating & Capturing Sharing & transferring Applying
Support of network lifecycle	Network building Network performance Network rebuilding/regression
Support of knowledge objects	Explicit knowledge Implicit knowledge

Sheet "Criteria for integration"

Integration object	Main questions
Integration knowledge processes	Which knowledge processes are integrated by the tool? Which interfaces to other knowledge processes do exist?
Integration support levels	Which level is supported by the tool? Individual, team, organization? Which interfaces to other levels are available?
Integration of knowledge objects (explicit and implicit knowledge)	Which knowledge is integrated by the tool? Which interfaces exist? How do the ‚transitions' between implicit knowledge and explicit knowledge look like?
Integration organization/ICT	How can organization and ICT be integrated?
Integration technology	Are different platforms supported? Which one?

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