During the pilot study, all participating employees were asked to fill out short online questionnaires and project managers were interviewed on a regular basis. The results of this study show a typical u-shaped curve concerning user satisfaction with the solution. It started out with high hopes, then some problems with the prototype and also the criteria that had not yet been sufficiently refined led to a decline in satisfaction. However, in the last three weeks of the pilot study, the curves reflecting usability, improvements in communication, efficiency, learning and knowledge transfer all showed a positive tendency. One has to be careful in interpreting these results, though. On the one hand, some participants feared that a flexible office would mean a loss of their personal work space and of their relationships with colleagues. On the other hand, more and more employees in the IT company claimed their interest in participating in flexible office because of the supposed benefits that this would have on their personal productivity and development. Longitudinal studies are required to see whether these personal opinions can really amount to measurable improvements in the dependent variables of this study, namely communication, search efficiency, knowledge transfer, learning and, finally, organizational success.

6.6 Modeling

Models are representations of a selected portion of the perceived reality of an individual or a group of observers. Central to models are their structural, functional or behavioral similarities to the perceived reality (Lehner et al. 1995, 26f). Modeling is one of the key tasks that helps on the one hand to understand, analyze and improve business processes (business process reengineering), organizational structures in general and structures and processes of KM initiatives in particular. On the other hand, modeling supports the design, implementation and management of information systems, in this case of knowledge management systems.

Based on the model of tasks and flows in knowledge management[391], the design of KM initiatives requires the modeling of concepts for

1. *instruments*[392] that have been selected in order to implement the KM strategy and aim at the desired outcome,
2. *processes*[393], the organizational design in which those instruments are deployed, i.e. knowledge tasks and processes, the relationship to business processes, roles and responsibilities,
3. *persons*[394], capturing facts about people as the target group of the instruments, i.e. their profiles, skills, communication and cooperation in organizational units, project teams, networks and communities,

391. See Figure B-25, “Knowledge process and knowledge-intensive business process,” on page 214.
392. See section 6.2 - “Instruments” on page 195.
393. See section 6.3 - “Process organization” on page 207.
394. See section 6.1 - “Structural organization” on page 158.

4. *products*[395], knowledge as object in the sense of themes, the type of knowledge, meta-data, structures, taxonomies and ontologies,
5. *ICT*[396] tools and systems in support of KM, i.e. the KMS architecture that integrates interacting basic services that are composed into advanced KM services.

Figure B-29 shows the most important KM modeling concepts structured according to these four categories and their relationships. The importance of the three main modelling perspectives person, process and product is stressed in Figure B-29 by the shaded triangle that visualizes them as being connected in the middle layer. The strategy-oriented selection of KM instruments on the top determines the modelling efforts in the middle layer whereas the subsequent implementation of ICT forms the ultimate modeling goal and thus limits and streamlines the modeling effort. The five perspectives are connected by a number of concepts.

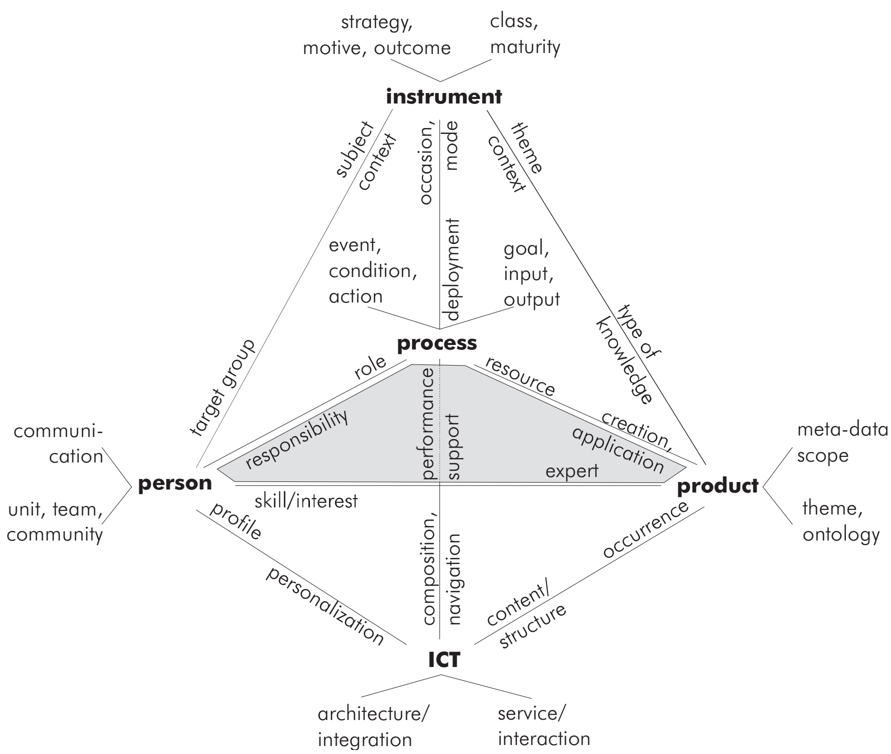

FIGURE B-29. Perspectives for modeling in knowledge management

KM instruments determine the target group in the person perspective and the type of knowledge focused in the product dimension. Processes on the one hand

395. See section 7.2 - "Contents" on page 281.
396. See section 7.3 - "Architectures and services" on page 302.

provide occasions for knowledge-oriented tasks and on the other hand are a primary vehicle for the implementation and deployment of KM instruments. In this view, person and product form subject and theme context for triggering KM instruments in the respective business and knowledge processes.

Persons are involved in processes by responsibilities for tasks and processes and roles that are assigned to tasks. Business and knowledge processes are supported by ICT tools and systems, especially KMS, in order to improve organizational performance. Also, processes can be used to guide composition of services and to aid navigation in ICT resources. Themes and topics in the product perspective are mapped to occurrences, e.g., documents or other resources that are stored in ICT systems. Structures, taxonomies and ontologies can be used as the primary structure of contents of ICT systems. Persons hold skills that are structured as topics and have interest in topics. Experts take care of certain topics in organizations, e.g., subject matter specialists. Processes and topics are connected by the knowledge resources, both in the form of skills and in the form of documents, that are required in business and knowledge processes and by the process context of knowledge, i.e. in which processes knowledge is created and applied, sometimes also called flow of knowledge. Identity management with the help of profiles and personalization techniques are used to support access of contents and services in ICT resources.

In a concrete KM initiative, modeling can be focused according to the two main directions of KM research, human orientation and technology orientation, and Hansen et al.'s (1999) distinction of KM strategies into a personalization versus a codification strategy[397].

In a human-oriented KM initiative, or a personalization strategy respectively, modeling focusses on the perspective person and its links to the product and process perspectives. Skills, interests, experts, roles, responsibilities, communication and social network analysis will be of interest to these KM initiatives.

In a technology-oriented KM initiative, or a codification strategy, modeling primarily is concerned with the product perspective and its relationships to ICT and process. The modelers model meta-data as well as ontologies and design architectures, services, contents and structures of KMS. Services are composed so that they can be deployed with the help of KM instruments to support performance in processes.

In a KM initiative aimed at bridging the gap between human orientation and technology orientation or between personalization and codification respectively, the process perspective is emphasized together with its relationships to the person, product and ICT resources perspectives. The design of knowledge processes and knowledge-intensive business processes with their roles and responsibilities, the types of knowledge created and applied as well as their support by ICT resources is as important as the design of the relationship between persons and ICT resources that supports profiling and personalization of ICT systems for KM.

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397. See also sections 4.1.4 - "Definition" on page 52 and 5.2.3 - "Generic knowledge management strategies" on page 129.

A large number of modeling approaches, methods and techniques have been developed in the literature. Examples are business process modeling, communication modeling, data modeling, data flow modeling, knowledge modeling or object-oriented modeling. Detailed descriptions of these and more modeling methods and techniques can be found in the literature[398]. This section reviews some of the modeling perspectives that have been proposed for KM and discusses their applicability for the design of KM initiatives that use KMS. These are process modeling and its extensions to cover aspects of KM (section 6.6.1), activity modeling, an approach to model ill-structured knowledge activities based on the activity theory (section 6.6.2), knowledge modeling (section 6.6.3) as well as person modeling, including user and role modeling, communication modeling and social network analysis (section 6.6.4). ICT are considered as resources that support or automate activities in process modeling methods, e.g., the execution of workflow definitions, as occurrences and media holding knowledge in knowledge modeling and as tools and systems that allow for profiling and personalization in person modeling. However, there is no specific section on the modeling of ICT resources in this book as existing methods, tools and techniques can be used for modeling this perspective, e.g., object-oriented modeling with UML.

6.6.1 Process modeling

Many organizations have applied concepts of business process reengineering (e.g., Davenport 1993, Hammer/Champy 1993) and a number of methods and techniques to support business process modeling have been proposed in the literature. There are a number of methods and techniques to support business process modeling discussed in the literature. As process modeling is a complex task that requires computer support in order to be an economically feasible approach, most methods are applied with the help of a corresponding tool. Examples are ADONIS (Junginger et al. 2000), the architecture of integrated information systems - ARIS (Scheer 1998, 2001), integrated enterprise modeling - IEM (Spur et al. 1996, Heisig 2002, 49ff), multi-perspective enterprise modeling - MEMO (Frank 1994, 2002), PROMET for process development (PROMET BPR) and for the process-oriented introduction of standard software (PROMET SSW, Österle 1995, 31ff), semantic object modeling - SOM (Ferstl/Sinz 1990, 1994, 1995) or business process modeling methods on the basis of the unified modeling language UML[399] (e.g., Oesterreich et al. 2003). These modeling methods are also called enterprise modeling methods because they integrate a number of perspectives on an organization, e.g., the data, function, organizational structure and the process perspective. Moreover, there is a number of frameworks and reference models for the definition of workflows that imple-

398. A good overview of techniques and modeling methods developed and applied in software engineering can be found in Balzert 2001.

399. UML, the unified modeling language, is a notation and semantics for the visualization, construction and documentation of models for object-oriented software development that has been standardized by the Object Management Group (OMG), URL: http://www.omg.org/.

ment business processes (see e.g., Kumar/Zhao 1999, WfMC 2007). The methods differ in formality, semantic richness and understandability. Basically, the modeling methods fall into two categories:

- methods that primarily aim at the design of organizational structures and processes with the resulting models being a tool for business process reengineering and improvement (e.g., ARIS) and
- methods that primarily aim at the design of information and communication systems, mostly on the basis of workflow management systems and using concepts of object-orientation in a process-oriented view of the organization (e.g., ADONIS or the modeling methods on the basis of UML).

The main challenge in the selection of a method for business process modeling is to balance understandability and ease of use on the one hand and preciseness and formality on the other hand. This is due to the fact that business process modeling is mostly used to design organizational structures and processes on an abstract level or to customize standard software, such as enterprise resource planning software, e.g., SAP R/3, basically by selecting the functions that have to be supported by the software. However, business processes can also be technically supported by workflow management systems which require a much more detailed description of business processes.

Recently, a number of authors have proposed extensions to business process modeling methods, notations or semantics that model (some of the) specifics of KM. Examples are:

ARIS-KM[400]. The architecture of integrated information systems was proposed by Scheer (1992) as a framework for the design and analysis of business processes and the design of information and communication systems in support of these processes. The extensions proposed to ARIS (Allweyer 1998) basically comprise the addition of (1) the object types *knowledge category* and *documented knowledge* and their relationships to activities, persons and organizational units, and (2) the model perspectives *knowledge structure diagram* that shows the relationships of knowledge categories and documented knowledge elements, *knowledge map* that maps knowledge elements to people and organizational units and *communication diagram* that shows which organizational units communicate with each other.

Business knowledge management. The business knowledge management framework, proposed by Bach and Österle (1999, 26), consists of the three layers (1) *business processes*, (2) *knowledge base*, that comprises KM roles, documents, systems and specific KM processes in the sense of service processes to business pro-

400. The ARIS method and toolset is widely used for business process management in the German-speaking countries. The extensions of ARIS for knowledge management are straightforward and pragmatic and yet can be regarded as being representative for many approaches to connect business process management and knowledge management. Therefore, the extensions to ARIS will be discussed in more detail below (see “Example ARIS for knowledge management” on page 245).

cesses, and (3) *knowledge structure*, i.e. the topics and categories of knowledge and their relationships. Topics are created and used in business processes, conceptualized as knowledge flows between business processes, stored in documents and systems, managed by KM roles, refined and distributed by KM processes, and thus mediate between the layers business processes and knowledge base.

The corresponding modeling method, PROMET®I-NET, is based on PROMET and aims at the design of an Intranet-based KM solution, mainly (1) the selection of business processes that use a substantial amount of (semi-) structured knowledge and/or involve a large number of locations which requires coordination and sharing of information, (2) the design of an information architecture which corresponds to the knowledge structure in the business knowledge management framework, (3) the design of an Intranet system architecture consisting of the tools and systems that provide the required functionality, e.g., for classification and structuring of information and knowledge objects, and personalization, and (4) the design of processes that manage the information and knowledge objects in the Intranet (Kaiser/Vogler 1999).

GPO-WM. This method extends the integrated enterprise modeling method and is called the business process-oriented knowledge management method[401]. GPO-WM consists of a procedure model, a model-oriented audit instrument that helps to determine strengths and weaknesses of the current handling of knowledge in the business processes as well as knowledge-oriented criteria and heuristics, all aiming at the design of a process-oriented KM initiative. From a modeling perspective, the extensions comprise (1) new types of resources used in tasks within business processes, i.e. *explicit* (documents, data bases) and *implicit* (persons) *knowledge*, structured in *knowledge domains*, (2) the so-called *basic KM tasks*, i.e. create, store, distribute and apply knowledge, which are identified and analyzed for each activity in the business processes, and (3) *best practices* as elements of construction for a process-oriented KM initiative, e.g., yellow pages, communities-of-practice, customer voice or process-rally, that are linked to activities in business processes.

KMDL. The knowledge modeler description language KMDL is based on the communication structure analysis (KSA)[402] (Gronau 2003). The basic object types in KSA are *task*, *position*, *information* and *information flow.* These basic object types are extended in KMDL in order to cover knowledge-related aspects of knowledge-intensive business processes. The extensions build upon the distinction between explicit knowledge (in documents or data bases) and implicit knowledge (in people's heads) and Nonaka's processes of knowledge conversion, i.e. internal-

401. In German: "Methode des Geschäftsprozessorientierten Wissensmanagements" (GPO-WM, Heisig 2002)
402. Kommunikationsstrukturanalyse, KSA, developed by Hoyer 1988 (cited from Gronau 2003, 11f) in order to analyze information-intensive processes of office information and communication systems.

ization, externalization, combination and socialization (Nonaka 1991, 98f). Consequently, KSA was extended by the additional object types (1) *knowledge object* that covers implicit knowledge in addition to information objects covering explicit knowledge, (2) *person* as an individual that provides and/or seeks knowledge objects and (3) *requirement of a position* that comprises a knowledge object that a position or, more precisely, an owner of a position, must have in order to accomplish the task(s) that are assigned to the position. The four processes of knowledge conversion link information objects and demand and supply of knowledge objects. A consequent application of KMDL is only feasible at a rough level of detail due to the substantial complexity that a detailed study of the processes of knowledge conversion on the level of individual employees would bring. Additionally, KMDL proposes a procedure model that consists of the five activities (1) identification of processes, (2) detailed study with interviews and checklists, (3) modeling, (4) feedback from interview partners as well as (5) analysis of strengths and weaknesses and reporting. This procedure model and the modeling work with KMDL is supported by the tool K-Modeler (Gronau 2003, 23ff).

PROMOTE. The PROMOTE framework, i.e. process-oriented methods and tools for knowledge management, builds on the business process management systems (BPMS) paradigm (Hinkelmann et al. 2002, Karagiannis/Woitsch 2002). The PROMOTE framework consists of a procedure model, a method to design process-oriented KM instruments and a tool that aids the modeling process and is based on the ADONIS toolset. The BPMS procedure model that already covers business processes and process knowledge is extended by functional knowledge and its context. More specifically, the extensions to the BPMS method and ADONIS toolset comprise (1) additional steps in the procedure model, especially the *identification of knowledge flows* which consists of knowledge-oriented modeling of business processes, the description of *knowledge-intensive tasks* including the persons and the organizational memory[403] that provide the knowledge and the determination of *types of knowledge* required in these activities, e.g., functional, rule, experience or case-based knowledge, and the modeling of *specific knowledge processes* that are then linked to knowledge-intensive tasks in the business processes, (2) the new model types *knowledge process*, *skill model* and *topic map* and (3) a PROMOTE engine that executes the knowledge processes. Compared to methods that primarily aim at the design of organizational structures and processes, PROMOTE targets a finer level of detail with the analysis of knowledge-intensive tasks instead of whole processes and primarily aims at the design of KMS, specifically of workflow management solutions that are extended to cover knowledge processes. Consequently, knowledge processes are quite pragmatic and are limited to basic knowledge-related tasks, such as define search context, search for authors or combine results, which can be supported by KMS. PROMOTE provides contextual meta-data that

403. The term organizational memory is used here in the sense of organizational memory information system to cover all explicit knowledge that is accessible with the help of an information and communication system (Hinkelmann et al. 2002, 67).

describes knowledge elements according to the topics the knowledge element describes (link to topic map), the knowledge-intensive tasks in business processes in which the knowledge element is created or required (link to business process model) and the persons that hold the knowledge element (link to skill model and organizational structure).

Knowledge-MEMO. The Knowledge-MEMO framework builds on the multi-perspective enterprise modeling framework (MEMO) proposed by Frank (1994, 2002). MEMO offers a generic conceptual framework to capture common abstractions of organizations. MEMO consists of the three perspectives (1) strategy, (2) organization and (3) information system. Each of these perspectives is structured by the five aspects (1) structure, (2) process, (3) resources, (4) goals and (5) environment (Frank 2002, 3). Thus, MEMO provides 15 foci of organizational modeling. A single modeling language supports one or more of these foci, e.g., the structure aspect of the information system perspective corresponds to an IS architecture, a data model or an object model. Knowledge-MEMO uses MEMO‘s foci and extends the modeling concepts and languages considered in MEMO. Examples for extensions are intangible assets, core competencies or topics in the strategy perspective, abilities and skills in the organization perspective and explicit knowledge in the information system perspective (Schauer 2004). One of the focal points in Knowledge-MEMO is the organizational design of a secondary organizational structure, e.g., projects or communities-of-interest, their link to business strategy and their support by information systems[404]. Knowledge-MEMO also contains an evolution model that is used to classify organizations according to their achieved level of KM. The model represents the starting point for procedure models that aim at improving an organizational KM initiative and set the focus on certain perspectives and aspects in Knowledge-MEMO. With respect to other process modeling methods or frameworks, MEMO can be characterized as a meta-framework to which other modeling languages can be mapped.

These are only some examples of approaches to extend business process modeling methods to cover aspects of knowledge management. Further efforts have been made, e.g.,

- by vendors of business process management tools. Besides ARIS, there are a number of business process management tools that recently have extended the object types and model types used in their modeling suites as well as the integration of business process models into KM-oriented ICT solutions, e.g., enterprise portals. One example is the INCOME suite (Get-Process AG) that combines the INCOME process designer tool with a navigation tool called INCOME knowl-

404. The concepts of Knowledge-MEMO are still under construction and will be presented in Schauer 2004. However, some preliminary results target e.g., the integration of project management and business planning (Fraunholz/Schauer 2003), an object-oriented meta-model for KMS architectures (Frank 1999) or, more specific, enterprise-wide project memory and management systems (Frank et al. 2001).

edge browser. The process designer tool extends the multi-dimensional models used in business process design, e.g., goal hierarchies and critical success factors, process model, organization model, data model, resource model, product catalogue, by knowledge structures, skill maps and knowledge maps that assign knowledge topics with roles and resources. The knowledge browser then integrates the models developed in the process designer in a portal environment and uses them to access the organizational knowledge base[405],

- by researchers in the area of workflow management systems who propose to use the knowledge externalized during build-time and run-time of workflow management systems and to extend the workflow definitions by knowledge objects that are provided and searched for in the course of knowledge-intensive tasks. Examples are KnowMore, WorkBrain, Workware and the Workflow Memory Information System (WoMIS) that explicitly aims at modeling and implementing context in the sense of an organizational memory information system (OMIS) with the components of a traditional workflow management system[406].

The reasoning behind all these extensions is that many organizations went to the trouble of a detailed analysis and modeling of their business processes, e.g., in the course of a major reorganization, quality management programs or the introduction of the standard software SAP R/3. Consequently, business process models already exist and simply have to be extended by concepts such as knowledge structures, required and provided skills or knowledge maps so that the extended models can serve as a basis for KM-specific analysis and design tasks.

A detailed discussion of the numerous approaches and methods for business process modeling in general and their extensions to cover aspects of KM in particular can not be given in this book[407]. Instead, according to the goals of this book, the ARIS method is described with respect to its applicability for KM as an example for a widely used business process modeling method.

Example ARIS for knowledge management. ARIS, the architecture of information systems, can be viewed as a framework consisting of the five perspectives (1) data, (2) function, (3) organization, (4) control and (5) output. Within each of these perspectives, a number of object types can be combined with the help of a number of modeling notations. An example is the entity-relationship model that comprises entities and relationships as object types in the data perspective that model events, messages and data objects in the ARIS meta-model. The perspectives overlap so

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405. The INCOME suite was originally developed by Promatis, Germany, URL: http://www.promatis.de/english/products/income_suite/index.htm/. Since February 2003, the Swiss company Get-Process AG is owner of the copyright for the INCOME suite and responsible for maintenance and development of the software, URL: http://www.get-process.com/.
406. See Wargitsch 1998 for the system WorkBrain, Goesmann 2002, 43ff and the literature cited there, see also Goesmann 2002, 166ff for the system WoMIS.
407. See e.g., Abecker et al. 2002, Goesmann 2002, 39ff, Remus 2002, 36ff and 216ff for a more detailed account of some of the approaches and modeling methods mentioned here.

that some of the object types can be used to join two or more perspectives. The ARIS framework integrates the five perspectives into one multi-perspective enterprise model and also offers a toolset that supports the design and navigation of ARIS models. So-called event-driven process chains are at the core of the integration in ARIS and bring activities, tasks or functions in a timely order, a chain of activities that are linked by events. Figure B-30 shows the ARIS meta-model with the five perspectives and the most important object types used to describe each of the perspectives. It also shows that the control perspective integrates all object types in an extended event-driven process chain[408].

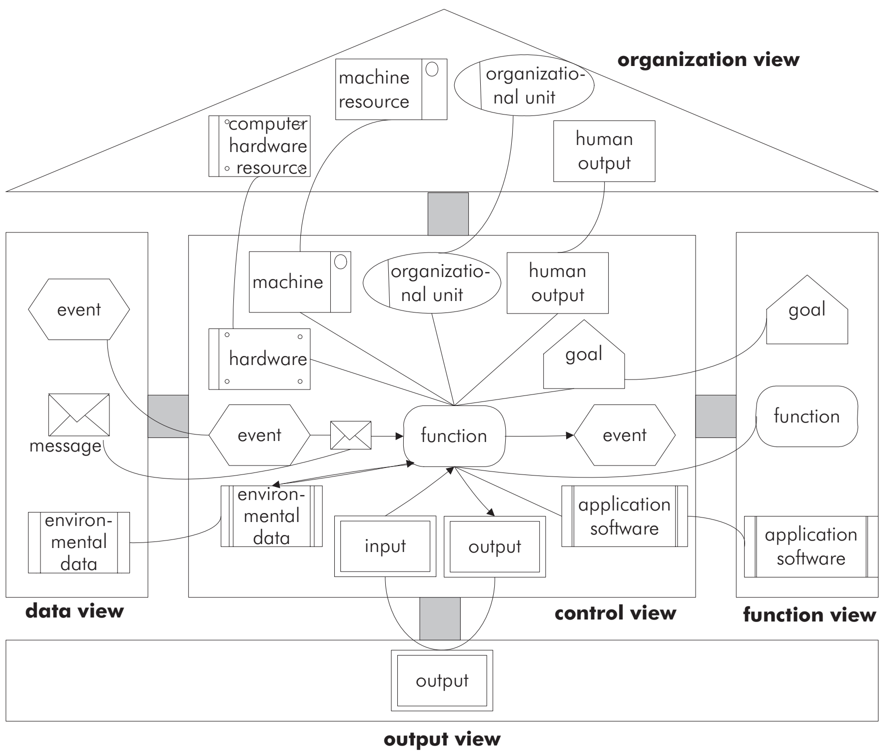

FIGURE B-30. ARIS meta model and perspectives[409]

The extensions to ARIS are relatively straightforward. The modeling method is extended by two additional object types, the object types *knowledge category* and *documented knowledge*. Knowledge categories as well as documented knowledge are treated like data objects and can thus be assigned to tasks in event-driven process chains. Figure B-31 shows an extended event-driven process chain that mod-

408. For a detailed description of ARIS see Scheer 2001.
409. Source: Scheer 1992, 22, Scheer 1998, 37.

els a portion of the core process of a typical small or medium-sized enterprise that makes dies and moulds[410].

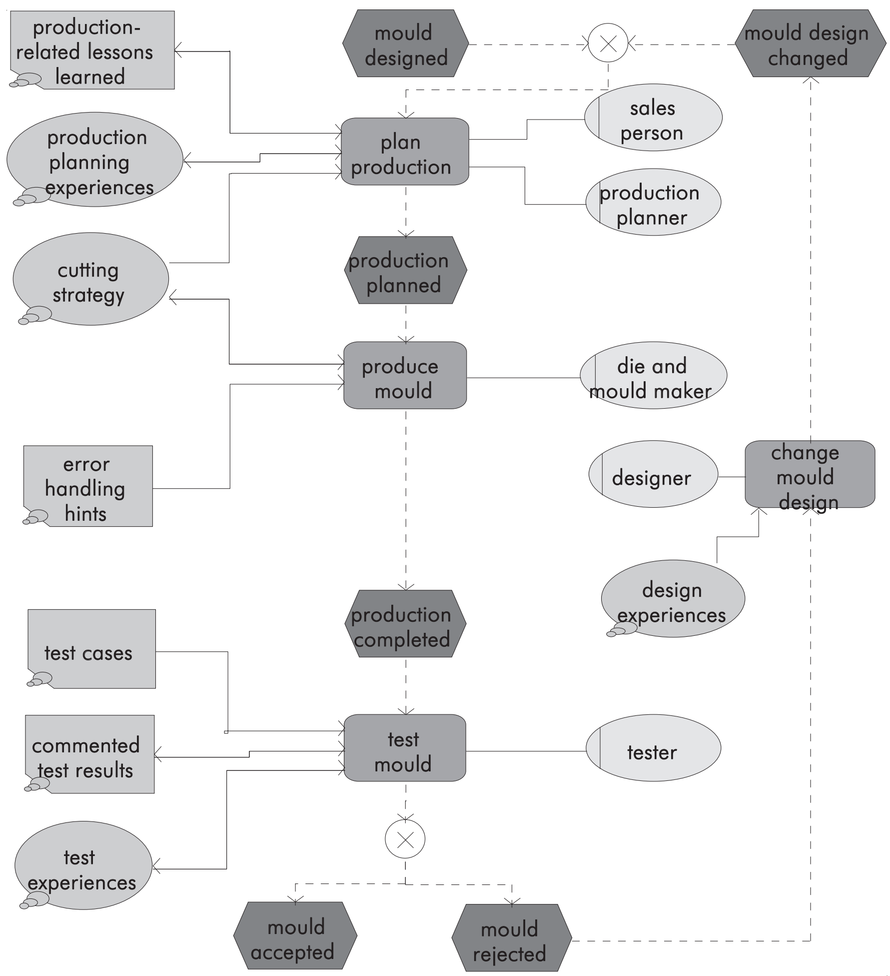

FIGURE B-31. Extended event-driven process chain with KM elements

The event-driven process chain is extended by a number of knowledge categories and documented knowledge. Also, ARIS is extended by additional model types within the existing perspectives, the model types (1) *knowledge structure diagram* in the data perspective, (2) the model type *communication diagram* in the

410. Figure B-31 to Figure B-33 show simplified portions of the models that were developed in the course of the EU project “KnowCom - Knowledge and Co-operation-Based Engineering for Die and Mould Making Small and Medium Enterprises” (KnowCom 2003).

organization perspective and (3) the model type *knowledge map* in the control perspective and (see Allweyer 1998).

ARIS knowledge structure diagram. Knowledge structure diagrams show the relationships (a) between knowledge categories and (b) between knowledge categories and documented knowledge. The diagram can be characterized as a simple form of knowledge modeling (see section 6.6.3). Thus, knowledge structure diagrams contain the object types *knowledge category*, *documented knowledge* as well as the object type *document* that visualize specific documents, e.g., text documents (see Figure B-32).

Additionally, knowledge structure diagrams assign documented knowledge to media and/or systems, e.g., to text documents that are stored in file systems or specific document, content or knowledge management systems[411].

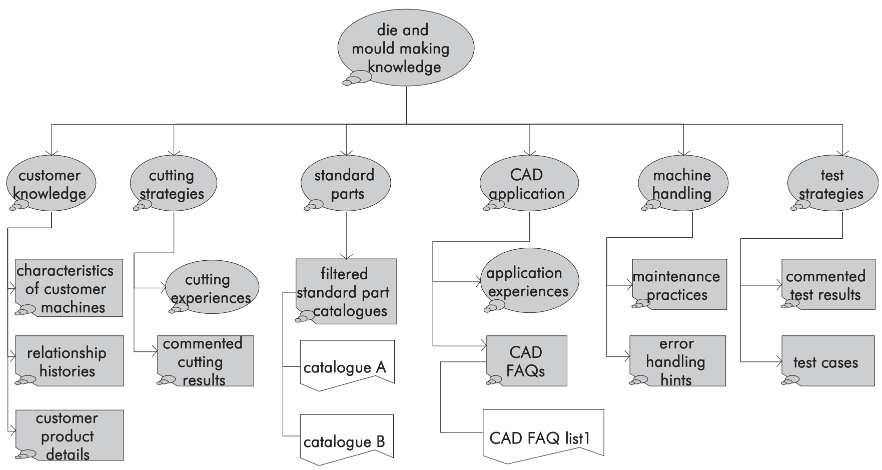

FIGURE B-32. Example for knowledge structure diagram in ARIS

ARIS communication diagram. Communication diagrams in ARIS visualize the communication links between organizational units and comprise the object type *organizational unit* and the object type *communication* (see Figure B-33).

The object type *communication* is labelled with the type of communication that characterizes the communication link. Organizational units are connected to communication with the help of a relationship *communicates with* that shows the direction of the communication. The relationship can be detailed according to what business processes a certain organizational unit communicates with another organizational unit.

411. The ARIS module "ARIS for Hyperwave" uses the knowledge structure diagrams and the assignments for the implementation of enterprise knowledge portals, e.g., by a translation into a description of folder structures and meta-data for the knowledge management system Hyperwave (URL: http://www.ids-scheer.com/).

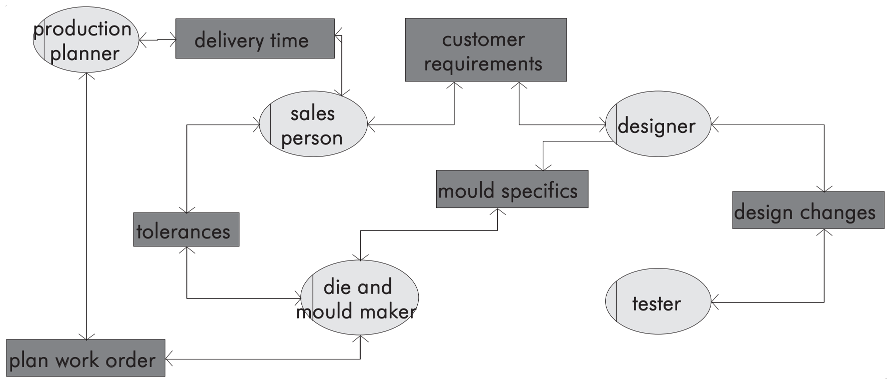

FIGURE B-33. Example for a communication diagram in ARIS

ARIS knowledge map. Knowledge maps in ARIS show which employees or organizational units hold what knowledge categories to what extent (see Figure B-34).

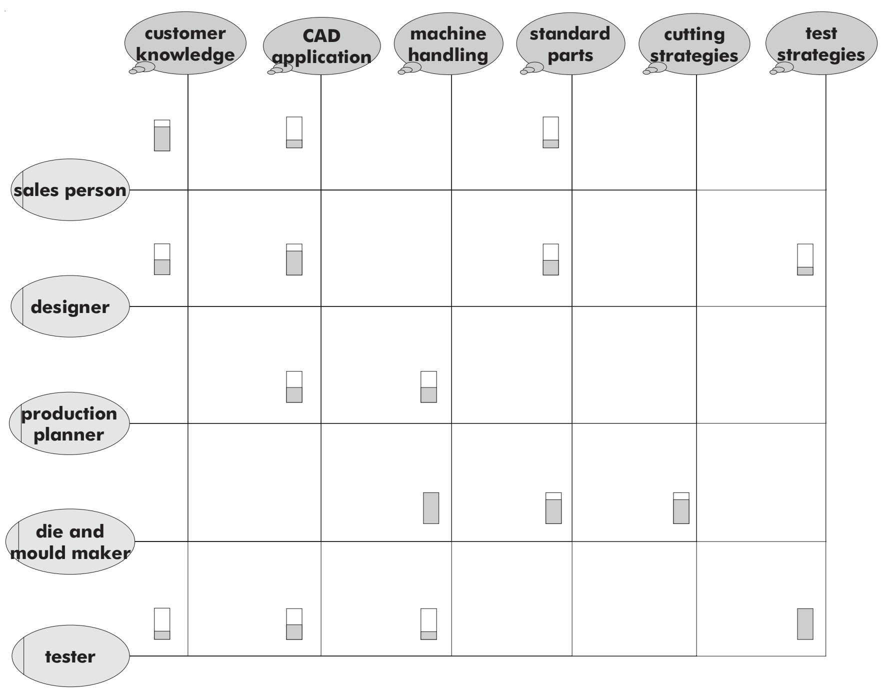

FIGURE B-34. Example for knowledge map in ARIS

ARIS knowledge maps therefore are a form of user/role modeling (see section 6.6.4). They take the form of a matrix that consists of the object types *person* and *knowledge category.* The relationships between persons and the knowledge categories they hold are visualized by bars that show to what extent a person holds a certain knowledge category. Compared to communication diagrams, knowledge maps represent a finer level of analysis. Whereas ARIS communication diagrams are restricted to the level of organizational units and thus naturally a high level of aggregation, knowledge maps show the relationships between individual persons and knowledge categories.

6.6.2 Activity modeling

Knowledge always undergoes construction and transformation when it is used. The acquisition of knowledge in modern learning theories is not a simple matter of taking in knowledge, but a complex cultural or social phenomenon. Thus, some authors suggest not to model knowledge as an object with its connotations of abstraction, progress, permanency and mentalism, but of the processes of knowing and doing which take place in a *(socially-distributed) activity system*[412].

Figure B-35 shows the elements of a socially-distributed activity system[413]. These systems provide a new unit for the analysis of the dynamic relationships among individuals (called agents or actors), their communities and the conception(s) they have of their activities (the inner triangle in Figure B-35). These relationships are mediated by instruments and concepts (e.g., language, technologies) used by the agents, implicit or explicit social rules that link them to their communities and the role system and division of labor adopted by their community (the outer triangle in Figure B-35, Blackler 1995, 1036ff).

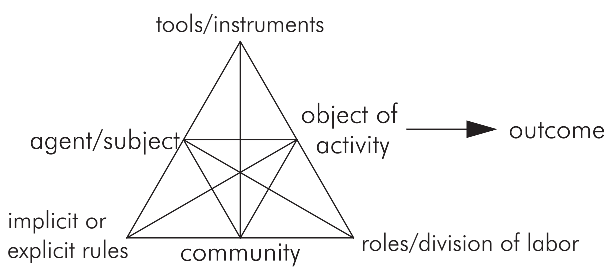

FIGURE B-35. Model of the socially-distributed activity system[414]

Table B-12 describes each of the elements used in the activity theory and gives some examples that help to understand the concepts.

Activities have a hierarchical structure (see Figure B-36): They are driven by common motives which reflect collective needs (Engeström 1999). They are accomplished by actions directed to goals coupled to the motives. There is a many-

412. Blackler 1995, Spender 1996a.
413. For a recent overview of activity theory e.g., Chaiklin et al. 1999.
414. The figure is based on Engeström 1987, Engeström 1993, 68, Blackler 1995, 1037, Engeström et al. 1999.

to-many relationship between activities and actions: an action could belong to multiple activities and the object of an activity could be reached by multiple alternative actions (Engeström 1999). Actions in turn consist of orientation and execution phase. The first comprises planning for action, the latter execution of the action by a chain of operations (Kuutti 1997). The better the model upon which planning is based fits the conditions, the more successful the action will be. Actions can collapse into operations, if the model is sufficiently accurate, so that no planning is necessary. Operations are executed under certain conditions and are the most structured part that is easiest to automate.

TABLE B-12. Elements of the activity theory[a]

element	**description**	**example**
object of activity	purpose and motives that define the reason why the activity exists and/or why the subjects participate in the activity	to learn how to write a scientific paper
agent/ subject	person(s) that perform(s) or participate(s) in an activity	Ph.D. student
outcome	intended and unintended results of the transformation process(es) performed in the activity	contributions to workshops and conferences, conference presentations, journal papers, contacts with colleagues
community	the collective of persons that are involved in the transformation process(es)	Ph.D. students, faculty, community of researchers in the discipline or area of research
tool/ instrument	material and immaterial instruments that are used in the activity	ISWORLD Web site, text processor, endnote tool, information systems, language, artifacts
role/division of labor	explicit and implicit organization of the relationships in the community	author, co-author, peer reviewer, referee, program committee, editor, publisher
rule	formal and informal norms, laws, regulations and principles that govern conduct, action and procedure in the activity and are imposed on the subject by the community	citation rules, conference/journal ranking, submission procedure, publication policy, ethics concerning plagiarism or double submissions

a. see also Engeström 1987, 1993, Engeström et al. 1999, Hasan/Gould 2003, 110.

An important feature of activity theory is the dynamic relationship between the three levels. Operations can again unfold into actions, e.g., if conditions change, as well as actions can become activities. Elements of higher levels collapse to constructs of lower levels if learning takes place. They unfold to higher levels if changes occur and learning is necessary.

Activity theory and process modeling have concepts in common, e.g., persons, resources, goals, but target different types of work practices. In the following, activity modeling and business process modeling are contrasted.

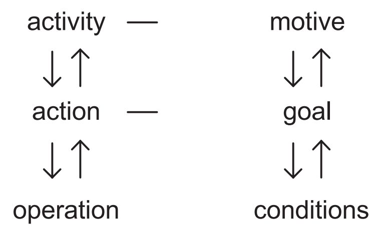

FIGURE B-36. Hierarchical structure of an activity[415]

Process modeling describes routine work solving structured problems that primarily aim at the exploration or application of knowledge. However, knowledge work does not fall into this category. Consequently, an alternative concept is needed to describe knowledge work. Still, processes describe the details of an organizational value chain that provides the main concept to ensure that activities in the organization are targeted towards creating customer value.

The concepts provided by activity theory are well suited to analyze the creative, unstructured and learning-oriented practices of knowledge work. However, although activity theory comprises motives and objects, they lack integration with the value chain, i.e., transformation processes in business settings. It is not ensured that activities are oriented towards creating customer value. Also, activity theory does not study the contributions of actions to the creation of customer value. Therefore, concepts of process orientation and of activity theory have to be combined in order to get a more comprehensive picture of knowledge work in a business context.

Nonaka's concept of the hypertext organization[416] can be used to describe this picture. It consists of the three layers (1) business system layer, (2) project system layer and (3) knowledge base layer and describes how employees can switch between different (hyper-)linked settings of an organization depending on their actual work practices. The business system layer might be described by concepts of process orientation and the knowledge base layer might be described by concepts of the activity theory. The project system layer connects these two layers. Projects can either target structured or unstructured problems and thus be studied by process models or activity models. It remains unclear how the relationship between these two layers can be modeled. In a first step, Figure B-37 maps business processes and activities on three levels and contrasts refinement in business process modeling and routinization in activity modeling.

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415. Source: Kuutti 1997.
416. See section "Hypertext organization." on page 159; see also Nonaka 1994, 32ff.

Business processes aim at improving work processes that can be characterized as routine, well structured or at least semi-structured processes that solve structured problems. Strategically, business processes primarily are the operational counterpart to exploitation as strategic focus for a certain competence and thus aim at the application of knowledge. Hierarchization in process modeling can be characterized as a refinement relationship consisting of the following three levels:

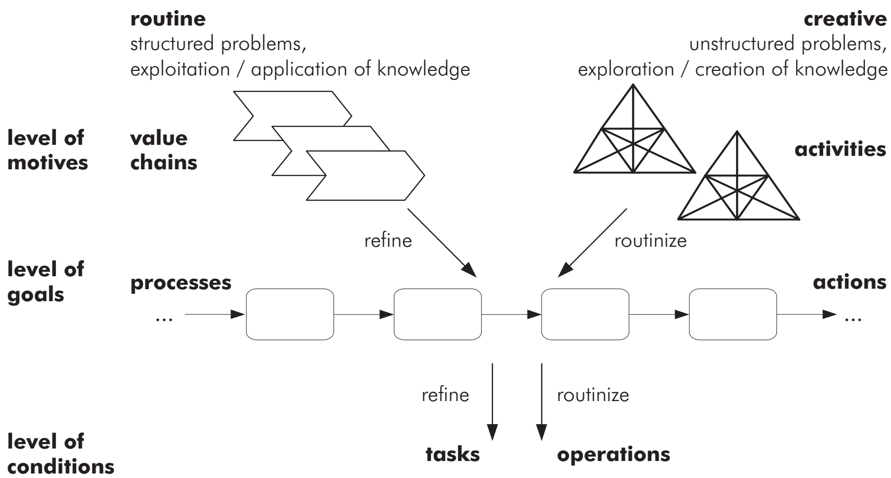

FIGURE B-37. Process modeling and activity modeling compared

- *value chains*: value chains are modeled by core and service processes relevant for an organization that can be visualized in a process landscape,
- *processes*: each of the processes in a process landscape can be detailed or disaggregated as a business process that consists of a sequence of events and functions, i.e. event-driven process chains[417],
- *tasks*: each function can be modeled in detail as a number of tasks that have to be fulfilled in order to accomplish a function's goals.

Activities model the organizational context of creative, often less foreseeable and ill-structured "processes" that focus unstructured problems. Strategically, activities in the sense of the activity theory primarily operationalize exploration as strategic focus. They aim at the joint creation of knowledge that is then applied in business processes. Hierarchization in activity modeling does not mean aggregation and disaggregation as in the case of business processes, but routinization of activities, and consists of the following three levels:

- *activities*: the term denotes the set of activities in an organization that is defined with respect to the strategic core competencies that have been identified in a process of strategy development[418],

417. See section 6.6.1 - "Process modeling" on page 240.

- *actions*: what has been learned by a person or a group of persons can then be used as a (routinized) skill or competence in a (series of) actions within a business process,
- *operations*: further routinization of actions yields operations, i.e. a detailed description of how to fulfill a task that is subject to automation or at least heavy support of ICT.

The three levels contrasted here can be characterized as level of *motives*, level of *goals* and level of *conditions*. Motives specified in a business strategy lead to the definition of a process landscape and of activities. Processes and actions both are performed in order to achieve certain goals that are determined considering the motives during process design and analysis of activities. On the finest level finally, conditions trigger tasks and operations. Value chain orientation and activity orientation could be integrated on the level of goals. On this level, actions could be connected to event-driven process chains. Concepts of process modeling and of activity theory provide two different perspectives on work practices in business organizations. The process-oriented perspective focuses implementation, exploitation, and accumulation of knowledge in the context of business processes. Some knowledge-related tasks may be described by knowledge processes and knowledge flows, i.e. by extended process modeling techniques. The activity-oriented perspective focuses creative, dynamic, and communication-intensive tasks, unstructured problems, membership in communities, self-organizing teams and demand for learning. A concept is needed that connects these two perspectives which is termed knowledge stance (see Box B-7, Hädrich/Maier 2004).

> A knowledge stance is a class of recurring situations in knowledge-intensive business processes defined by occasion and context, in which a person can, should or must switch from a business-oriented function to a knowledge-oriented action.

BOX B-7. **Definition of knowledge stance**

Both perspectives and the concept of knowledge stance are shown in Figure B-38. In a process-oriented perspective, an employee accomplishes functions on the level of goals that belong to business processes by fulfilling a sequence of tasks on the level of conditions. Simultaneously, she can be involved in one or more activities framing knowledge-oriented actions necessary to complete the functions.

An activity can be focused on the business process or a more general activity pursuing a motive not related to the business process, e.g., an effort to build competencies related to other topics or business processes. In contrast to the clearly

418. See also the framework for the definition of a process-oriented KM strategy presented in section 5.1.3 - “Process-oriented KM strategy” on page 108. Core competencies and strategic knowledge assets guide the design of activities which are routinized in actions as part of knowledge processes and knowledge-intensive business processes.

defined sequence of events and functions, there is no predetermined flow of actions. Activities, corresponding actions and operations can (a) be focused on the business process or (b) pursue a motive not related to the business process, e.g., an effort to build competencies, and thus may make a direct or a more indirect contribution to the process goal.

A business process offers several occasions to learn, to create or integrate knowledge related to core competencies of the organization. Occasions trigger knowledge stances and are associated with the functions of which the business process is composed. Occasions offer the opportunity or create the need for knowledge-related actions. A knowledge stance is not limited to creation of knowledge, but may also include translation and application of knowledge created outside the knowledge stance which in turn offers the possibility to create knowledge. Examples for occasions are treatment of exceptions, reflection in order to build knowledge with respect to core competencies of the organization.

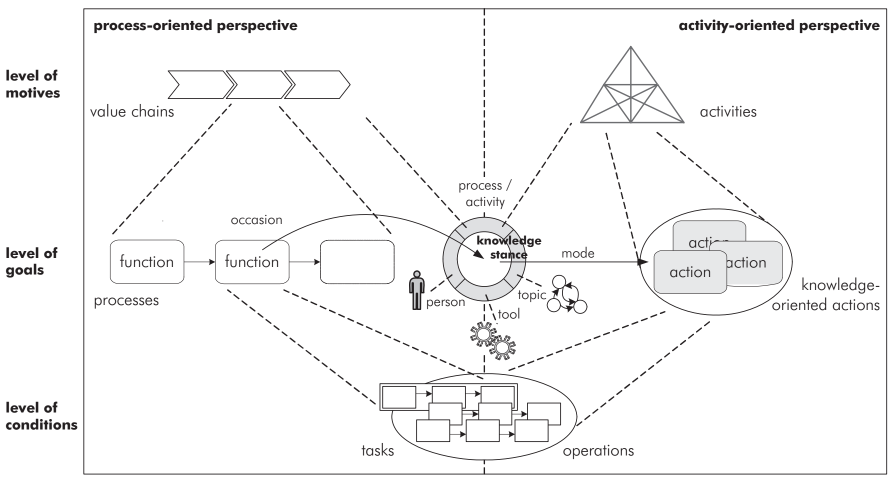

FIGURE B-38. Concept of knowledge stance

Context. This concept comprises all relevant dimensions suitable to describe the actual situation of the worker. Context is classified in process- and activity-oriented perspective on two levels of granularity, i.e. individual function/action or entire process/activity, as well as in type and instance level (based on Goesmann 2002). Instance level means in this case that context is restricted to the work order or action actually processed. Context on the type level refers to all work orders or actions of the same type.

Examples for relevant dimensions are elements of the related activity and the process, e.g., artifacts like software tools, diagrams, knowledge maps, other subjects involved, desired outcomes, relevant roles, rules, e.g., user rights, members of the community important for the user, e.g., with whom she communicates regularly, as well as other process steps connected by knowledge flows. The two dimensions location and time should also be included as they are important parts of the context.

In order to support knowledge stances with ICT, context should be derived automatically as far as possible by the KMS or the workspace in use on the basis of usage history or information about the participant. The currently best way to represent context and relations between context elements seems to be with the help of an ontology[419].

Mode. Mode classifies actions, or knowledge routines, that can be performed and refers to four informing practices (see Schultze 2000, 2003): (a) ex-pressing is the practice of self-reflexive conversion of individual knowledge and subjective insights into informational objects that are independent of the person, (b) monitoring describes continuous non-focused scanning of the environment and gathering of useful just in case-information, (c) translating involves creation of information by ferrying it across different contexts until a coherent meaning emerges, and (d) networking is the practice of building and maintaining relationships with people inside and outside the organization.

Actions. Context, mode and occasion are means to specify the set of available, allowed, recommended or required partly routinized activities which can be supported by arrangements of knowledge management services[420]. A straightforward approach to support knowledge actions is to automate corresponding operations that accomplish the action. They are highly dependent on the stance and thus must obtain information from context variables as well as mode and occasion of the knowledge stance. This could be accomplished e.g., by offering workflows to automate actions or to guide the user by wizards known from office applications. Examples are actions to integrate, validate, distribute or annotate knowledge elements.

From the perspective of designing KMS, those knowledge stances are of primary interest that can be supported by ICT. Depending on occasion, context and mode, it can be decided which parts of the KMS, i.e. contents and services, are suited to support the selected knowledge-oriented action. With respect to the characteristics of KMS[421], knowledge stances represent situations in which an arrangement or a bundle of knowledge management services can be suggested to complete knowledge-oriented actions. In some cases, flexible knowledge processes can be offered. Due to activities framing the social system in which knowledge is handled, the specifics of knowledge are considered when designing a comprehensive platform for supporting occasions to explore or exploit knowledge in business processes. Knowledge stances also provide a concept to connect KM instruments to business processes. For example, in a certain knowledge stance, a KMS could sug-

419. See sections 6.6.3 - “Knowledge modeling” on page 257 and 7.7 - “Semantic integration” on page 374.
420. See also section 7.3.1 - “Knowledge management service” on page 302.
421. See section 4.3.2 - “Definition” on page 86.

gest to document a personal experience or to start a lessons learned process depending on the activity context and the activities other members of the community are currently engaged in.

Context should be derived with as little user effort as possible. Currently opened documents on the desktop, emails in the mailbox or the history of the Web browser could be used to determine parts of context information. This could be enriched by data about the current function in the business process the user performs and data about actions that other users took in similar situations. Furthermore, awareness services could monitor current activities of other employees relevant in the knowledge stance and thus be helpful in analyzing which cooperation partners are currently available or even engaged in similar business-oriented functions or knowledge-oriented actions respectively. Context elements and their relation can be represented by a standardized or shared ontology. Thus, inference techniques can be applied and context can be communicated to and translated for other applications.

6.6.3 Knowledge modeling

Knowledge modeling aims at a formal description of (documented) organizational knowledge that can be processed by computers and at a visualization of the topics that are of interest in a KM initiative and/or that are supported by the contents of a KMS and their relationships. There are relationships (1) between topics and persons, knowledge maps (see section 6.6.4), (2) between topics and ICT systems, especially which documents and other resources contain information on a certain topic and how they are related to each other as well as (3) relationships between topics themselves. The extensions of process modeling methods to capture knowledge structures have already shown the importance of explicitly modeling topics and structures in an organization's knowledge base.

Knowledge modeling techniques and methods differ with respect to the degree of formality that they focus. On the one hand, methods and techniques from the field of artificial intelligence and knowledge-based systems are highly formal and represent knowledge in the form of rules, frames, semantic nets, with the help of a variety of logic languages (e.g., Prolog)[422]. In the field of KM, particularly knowledge representation with the help of ontologies or domain models that can be processed by computers has gained widespread attention and use in practical example cases. On the other hand, knowledge mapping techniques often primarily serve as a tool for human beings to better understand the (highly aggregated) structure of important areas of knowledge or competence and their relationships to, e.g., the persons, groups or other organizational units that create, hold, seek, distribute or apply the knowledge[423].

Explicit modeling of computer-understandable knowledge that is similar to knowledge-based systems has been an important stream within knowledge man-

422. See textbooks on knowledge-based systems or logic, with an emphasis on knowledge management e.g., Karagiannis/Telesko 2001, 53ff).
423. See e.g., Eppler 2003a.

agement. Several groups of authors have recently extended methods, techniques and tools that were originally developed to model knowledge used in knowledge-based systems to cover aspects of KM. Examples are the CommonKADS method (Schreiber et al. 1999) or the many applications of ontologies in KM that have been shown by the Institute AIFB of the University of Karlsruhe and the company Ontoprise that develops the ontology modeling and brokering tools OntoStudio and OntoBroker[424].

The two terms *ontology* and *taxonomy* are used widely for the results of modeling efforts. Depending on the semantic richness of the constructs that can be used to formalize topics, knowledge objects and their relationships, some authors distinguish between (simpler) taxonomies and (more powerful) ontologies. In the following, these two terms and their usage in KM(S) are briefly reviewed.

Taxonomy. The term taxonomy denotes the classification of information entities in the form of a hierarchy, according to the presumed relationships of the real-world entities that they represent (Daconta et al. 2003, 146). A taxonomy can contain definitions and explanations, synonyms, homonyms and antonyms, as in a thesaurus. A taxonomy is often modeled as a hierarchy of terms and can be used as the semantic basis for searching and visualizing a domain, e.g., a collection of documents. Figure B-39 gives an example of a well-known taxonomy developed in the discipline of biology. There is only one type of hierarchical relationship between concepts in a taxonomy, in this case the *belongs_to* or *subset_of*-relationship.

- Kingdom: Animalia
  - Phylum: Chordata
    - Subphylum: Vertebrata
      - Class: Mammalia
        - Subclass: Theria
          - Infraclass: Eutheria
            - Order: Primates
              - Suborder: Anthropoidae
                - Superfamily: Hominoidae
                  - Family: Hominidae
                    - Genus: Homo
                      - Species: Homo Sapiens

FIGURE B-39. Example taxonomy[425]

Ontology. “An ontology is a (1) formal, (2) explicit specification of a (3) shared (4) conceptualization” (Gruber 1993, 199). More specifically, an ontology “defines the basic terms and relations comprising the vocabulary of a topic area as well as the rules for combining terms and relations to define extensions to the vocabulary“[426]. (1) An ontology has to be formal which requires that the ontology is

424. See URL: http://www.ontoprise.de/, Staab et al. 2001, Staab 2002.
425. Daconta et al. 2003, 148.

machine-readable. However, there are different degrees of formality of ontologies, from a thesaurus like WordNet to ontologies capturing formal theories for common-sense knowledge like Cyc. (2) Explicit specification means that the concepts and relationships as well as constraints on the use of concepts are defined openly and not left to the interpretation of the ontology's users. (3) Shared refers to the requirement that the conceptualizations made in an ontology have to be agreed upon by a group of people that intend to use the ontology for knowledge exchange. (4) Finally, conceptualization is an abstract model, a representation of a domain or phenomenon which investigates the concepts of that domain or phenomenon that are relevant to the ontology's users.

Ontologies generally can be used for (1) communication between computational systems, between humans and between humans and computational systems, (2) computational inference, for internally representing and manipulating plans and planning information and for analyzing the internal structures, algorithms, inputs and outputs of implemented systems in theoretical and conceptual terms, (3) reuse (and organization) of knowledge, for structuring or organizing libraries or repositories of plans and planning and domain information (Gruninger/Lee 2002, 40).

Typical uses of ontologies in KM fall into the first category. Ontologies here are formal models providing a shared and/or common understanding of an application domain communicable between people and application systems that help to define, retain, exchange and share knowledge with the help of ICT systems and thus facilitate representation, storage, communication and search of knowledge (O'Leary 1998, 58, Davies et al. 2003a, 4f). Ontologies are therefore developed to provide machine-processable semantics of data and knowledge sources that are accepted by a group of users and facilitate semantic integration, knowledge sharing and reuse[427]. Ontologies are not static, but evolve over time. An ontology not only defines basic terms and relations comprising the vocabulary of a topic area, but also comprises rules for combining terms and relations to define extensions to the vocabulary. Ontologies model (1) objects in domains, (2) relationships among those objects, (3) properties, functions and processes involving the objects and (4) constraints on and rules about objects (Daconta et al. 2003, 190). Thus, ontologies support clear-cut, concise, semantically rich and unambiguous communication between persons aided by KMS and/or between different KMS.

Compared to the term taxonomy, the term ontology is usually used not only to describe definitions of terms, basic properties and relationships between terms, e.g., *is_a*-relationship, but also to support an extended set and a variety of types of relationships, e.g., symmetric, transitive or inverse relationships, and rules that allow for reasoning about concepts and instances defined in the ontologies. Figure B-40 illustrates a portion of an ontology with definitions of concepts, relations and instances as part of an ontology assigned to the URI "http://onto.org". In the example, employees are defined as persons including the transitive relationship

426. Neches et al. 1991, 40, cited from Zelewski 2002, 6.
427. See section 7.7 - "Semantic integration" on page 374.

of the reporting hierarchy. Themes are defined as related to each other in a symmetric relationship and treated on events and in publications, defined in the inverse relationship `deals_with` and `is_about`. The concepts are illustrated with the help of several instances. `Book` as sub-concept of `Publication` "inherits" the relation `is_dealt_with` and thus can also be assigned to `Theme`.

The concept of rule is used e.g., to check not only syntactic, but also semantic validity of a statement or that is used to derive new properties of terms and relationships between terms from existing ones. Semantic rules, e.g., in the form of inference rules, describe how knowledge can be gained from existing statements (Zelewski 2002, 7).

```
  << Concepts >>
#Person@"http://onto.org".
#Employee::#Person.
#Theme@"http://onto.org".
#Event@"http://onto.org".
#Publication@"http://onto.org".
#Book::#Publication.
  << Relations >>
#Employee[#reports_to=>>#Employee@"http://onto.org".
#Theme[#has_expert=>>#Person@"http://onto.org".
#Theme[#has_related_theme=>>#Theme@"http://onto.org".
#Theme[#is_dealt_with=>>#Event@"http://onto.org".
#Theme[#is_dealt_with=>>#Publication@"http://onto.org".
#Event[#is_about=>>#Theme@"http://onto.org".
#Publication[#is_about=>>#Theme@"http://onto.org".
relation_property_(#Theme, #has_related_theme, symmetric)@
     "http://onto.org".
relation_property_(#Employee, #reports_to, transitive)@
     "http://onto.org".
inverse_relations_(#Theme, #is_dealt_with,#Event,
     #is_about)@"http://onto.org".
  << Instances >>
#"Alice Aberdeen":Employee@"http://onto.org".
#"Knowledge Management":Theme@"http://onto.org".
#"Knowledge Management Systems":Book@"http://onto.org".
#"IKNOW":Event@"http://onto.org".
#"Knowledge Management"[#is_dealt_with->>#"IKNOW"]@
     "http://onto.org".
#"Knowledge_Management"[#is_dealt_with->>#"Knowledge
     Management Systems"]@"http://onto.org".
```

FIGURE B-40. Example definitions of concepts, instances and relations

An example is: if two companies operate in the same industry and the same geographic region, then they are competitors (Figure B-41). The definition of the term ontology is broad enough to cover different types of ontologies that play a number of roles in developing KMS (Fensel 2004, 5f):

- *domain* ontologies capture knowledge of a particular type of domain and are thus restricted to the context of this domain,
- *meta-data* ontologies provide a vocabulary used to describe contents in an EKI, e.g., the Dublin Core meta-data standard,
- *common-sense* ontologies capture basic notions and concepts for e.g., time, space, state, event and relationship that are valid across several domains,
- *representational* ontologies comprise definitions of ways to represent knowledge and are not restricted to particular domains, e.g., frame ontology defining concepts such as frame, slot, slot constraint that can be used to explicate knowledge in frames,
- *method and task* ontologies provide concepts specific to particular problem-solving methods, e.g., the concept correct state in a propose-and-revise method ontology, or concepts specific for particular tasks, e.g., the concept hypothesis in a diagnosis task ontology.

```
FORALL company1, region1, sector1, company2
  company1[#is_competitor->>company2]@"http://onto.org" <-
  company1[#operates_in->>region1]@"http://onto.org" AND
  company1[#operates_in->>sector1]@"http://onto.org" AND
  company2[#operates_in->>region1]@"http://onto.org" AND
  company2[#operates_in->>sector1]@"http://onto.org".
```

FIGURE B-41. Example rule

Ontologies can be formalized with the help of a number of languages, e.g., F-Logic as depicted in Figure B-41, that are in turn supported by tools, e.g., Ontobroker[428]. However, the term ontology is sometimes used to describe conceptualizations on a spectrum that extends from weak to strong semantics starting from *taxonomy*, via *thesaurus* and *conceptual model* to *logical theories* that describe semantically rich, complex, consistent and meaningful knowledge (Daconta et al. 2003, 156ff).

Most organizations that are about to implement or have implemented a KMS have also created at least a minimal taxonomy or ontology (O'Leary 1998, 58). However, development and continuous maintenance of an ontology requires a substantial amount of effort. Also, ontologies developed individually in organizations are likely to be incompatible and thus cannot be used to share knowledge across organizational boundaries. Consequently, there is a need for standardization, both in the language used to develop an ontology and also with respect to the content of ontologies.

428. URL: http://www.ontoprise.de/.

An example for a standardization effort aimed at the description of documents with the help of meta-data is the Dublin Core structure[429]. Other examples for semantically richer standardization efforts are discussed in the field of the Semantic Web such as RDF, RDF Schema, DAML+OIL and OWL[430]. There has been put a lot of effort into semantic integration, namely meta-data standards and the standardization of languages that can be used to describe semi-structured data, such as documents, and their handling with the XML standards family which will be described in section 7.7 - “Semantic integration” on page 374.

6.6.4 Person modeling

Person modeling captures that portion of the context of KM initiatives that refers to people. The explicit or implicit modeling of user profiles has had a long tradition in human-computer interaction. User models are required for ICT systems to better adapt to the needs of human beings (e.g., Mertens/Griese 2002, 27ff). In KM, the adaptation of ICT systems to the needs of knowledge workers plays an important role that has been termed personalization. Figure B-42 shows the process of profiling and the subsequent application of the collected and analyzed profiles to personalize KMS. The grey arrows visualize the data flow between knowledge workers, the steps and the data base holding the user profiles. The black arrows visualize the process of the steps.

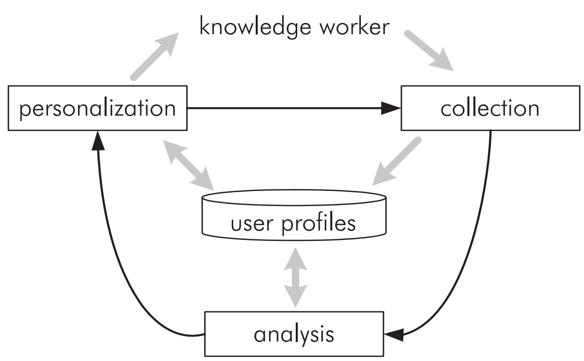

FIGURE B-42. The process of profiling and personalization[431]

The *collection* of information can be:

- explicit with the help of a number of questions that the user answers,

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429. URL: http://www.dublincore.org/; see also section 7.7.2 - “Meta-data management” on page 379.
430. RDF stands for Resource Description Framework, DAML stands for DARPA (Defense Advanced Research Program) Agent Markup Language, OIL stands for Ontology Inference Layer; OWL stands for the Web Ontology Language; see section 7.7.1 - “Semantic Web” on page 375.
431. The figure is based on Frielitz et al. 2002, 545.

- implicit by observing user behavior, e.g., user tracking or click stream analysis,
- based on a combination of data collected from other systems, e.g., enterprise resource planning systems or human resource management systems.

Analysis of the collected information requires:

- data mining, e.g., the selection, cleansing, transformation and analysis of relational data, e.g., skill or interest profiles, in analogy to data warehouses and customer relationship management systems,
- text mining, e.g., the analysis of submitted documents or of contributions in newsgroups,
- Web content, structure and usage mining, e.g., the analysis of log files of an Intranet platform or a knowledge management system.

Finally, *personalization* can be:

- user-initiated by explicit user statements,
- KM-initiated, e.g., by predefined "if-then" rules, e.g., data, role, event or time-driven triggers,
- automated content-based filtering, e.g., by comparing user profiles with the contents of the knowledge base,
- automated collaborative filtering, e.g., "communities of preference", active recommendations by other users, automated or hidden recommendations.

Moreover, person modeling in KM covers the following three aspects:

- *formal organization*: person modeling considers the formal organizational structure with e.g., roles, positions, work groups and organizational units.
- *informal organization*: on the other hand, knowledge management is particularly interested in the informal relationships between members of the organization, their communication, social networks as well as communities of practice or communities of interest.
- *skill management*: a third part of person modeling assigns actual employees, not roles or positions, to the skills they hold.

Formal organization and communication modeling in connection with process modeling have already been described in the course of process modeling[432]. In the following, methods and techniques of knowledge mapping and of social network analysis are discussed with respect to their contribution to skill management and the analysis of the informal organization.

Knowledge maps. Eppler (1997, 2003a) distinguishes several types of knowledge maps depending on what kind of elements are mapped to the knowledge domain or topic. He explicitly mentions three groups of elements:

- experts, project teams, or communities,
- white papers or articles, patents, lessons learned, or meeting protocols,

432. See the organization view and the communication diagram of the ARIS meta-model in section 6.6.1 - "Process modeling" on page 240.

- data bases or similar applications, such as expert systems or simulations.

This leads to the following types of knowledge maps (Eppler 2003a, 192f):

- *knowledge source maps* help to visualize the location of knowledge, either people (sometimes also called knowledge carrier maps) or information systems and their relation to knowledge domains or topics. They can be further classified into knowledge topographies to identify gaps, competence maps to find experts and pointer systems that directly link from challenges within a process to a contact that can assist. Knowledge source maps are used if not only people with knowledge in the desired domain are listed, but also all forms of codified knowledge (see above) that are relevant,
- *knowledge asset maps* is a further enhancement of the knowledge source map as it visualizes not only that there is knowledge in a document or person, but also the amount and complexity,
- *knowledge structure maps* show the relationship between different knowledge domains or topics and should not only visualize that there is a relationship, but also explain the type of relationship (belongs to, how it is related, etc.),
- *knowledge application maps* are a combination of process models and knowledge carrier maps as they describe who should be contacted for help at what step in the process,
- *knowledge development maps* visualize the learning paths that are required to acquire a certain skill as an individual or a certain competence as a team or other organizational unit.

The procedure to create knowledge maps is a five step process that can briefly be described as follows (Eppler 2003a, 202):

- identify knowledge-intensive processes or issues,
- deduce relevant knowledge sources, assets or elements,
- codify these elements, build categories of expertise,
- integrate codified reference information on expertise or documents in a navigation and/or search system that is connected to the work environment of the target group,
- provide means of updating the knowledge map, especially enabling decentralized update mechanisms so that every employee can (re-)position himself continuously within a knowledge map.

There is no standard that describes how knowledge maps should be visualized. Thus, the development of knowledge maps provides a great deal of freedom for both the determination of what elements and relationships should be part of the models and how they should be visualized.

Figure B-43, Figure B-44 and Figure B-45 give examples of knowledge maps and show the variety of approaches to their design (further examples can be found e.g., in Eppler 2003a).

Figure B-43 maps central areas of competence in an IT consulting organization and employees according to their expertise. The bars indicate whether an employee holds basic knowledge, expert knowledge or is a leader in the corresponding area of competence. The map shows the importance of Mr. Tinner and Mr. Ehrler for the organization because they seem to be competent in (almost) all relevant areas of competence.

Consultants	IT	Strategy	M&A	Accounting	Marketing
Tinner, Jeff	leadership	expert knowledge	basic knowledge	basic knowledge	
Borer, André		basic knowledge			expert knowledge
Brenner, Carl	basic knowledge				
Deller, Max					expert knowledge
Ehrler, Andi	expert knowledge	expert knowledge	basic knowledge	leadership	expert knowledge
Gross, Peter	basic knowledge	basic knowledge			basic knowledge
…				expert knowledge	leadership

expert knowledge   basic knowledge   leadership

FIGURE B-43. Example for a knowledge asset map[433]

Figure B-44 shows a portion of the knowledge source map of a multimedia company that develops Web sites, CD ROMs and stand-alone multimedia terminals.

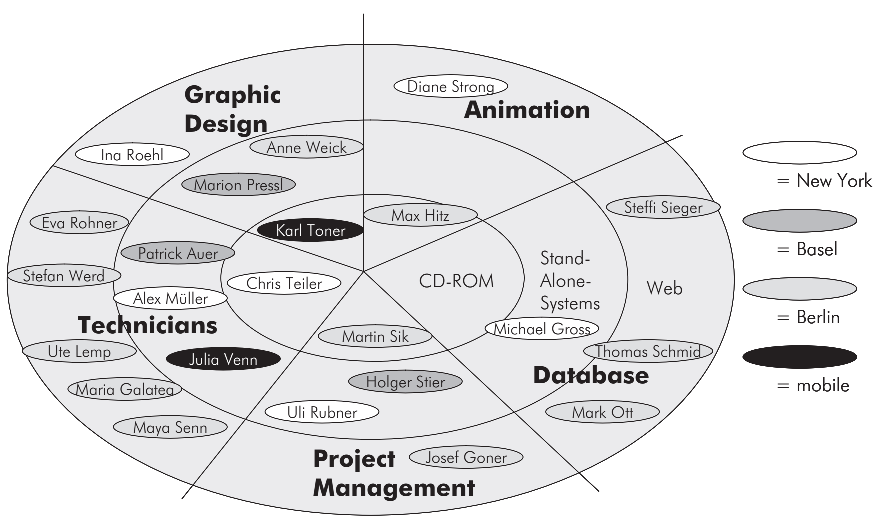

FIGURE B-44. Example for a knowledge source map[434]

433. Source: Eppler 2003a, 196

The map supports staffing of multimedia projects. The map visualizes what experts are available for the company's five areas of competence animation, data base, graphic design, project management and technology know-how and the three product lines Web systems, stand-alone systems, CD-ROMs, at the company's three main locations Basel, Berlin and New York. Additionally, two employees are not located in a single office, but float between the three locations.

Figure B-45 shows a portion of the main knowledge structure used by the author's work group as the central access structure to a knowledge workspace implemented in the knowledge management system Open Text Livelink[435].

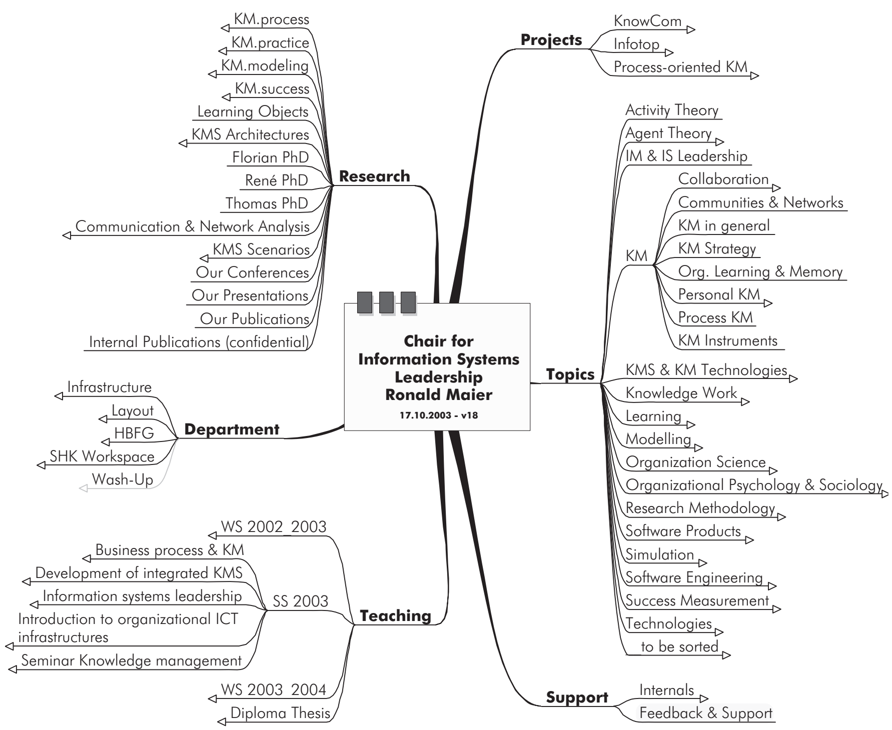

FIGURE B-45. Knowledge map of the structure of a knowledge workspace

The first level of the knowledge structure consists of the terms department, projects, research, support, teaching and topics. Thus, it reflects the two core processes of a university department, research and teaching. In the research branch, there are a number of workspaces to support specific research streams that the work group is engaged in. This includes the Ph.D. workspaces of the research assistants. Teaching contains workspaces for each individual course or seminar.

434. Source: Eppler 2003a, 195
435. See also section 7.4.9 - "Example: Open Text Livelink" on page 336.

Students have access to a portion of the material in the workspaces of the courses that they are enrolled in. Moreover, they can contribute to the workspaces and share knowledge with their colleagues. Projects represent units of funded thematic research. and of cooperations with other institutions. Topics are the primary structure to organize e.g., electronic research articles, news, contributions to newsgroups or empirical data that has been collected by the members of the work group. Department reflects internal projects and collaboration workspaces for the work group's teaching assistants. Support is a category in which the work with the KMS is supported and reflected. Arrowheads at the end of the branches represent collapsed hierarchies that are not visualized in the map.

The map can be automatically generated by a script that exports Livelink's structure, imports it into MindManager[436] and serves as an alternate way to access the knowledge elements stored in Livelink. Each branch in the map contains a hyperlink that directly links to the corresponding object in Livelink.

Knowledge structure maps differ widely between organizations. The maps usually represent the primary instrument to structure the organization's knowledge objects and thus are an important navigation aids.

Analysis of social networks. As stated before, knowledge management is concerned with both types of knowledge: knowledge as an object or product and knowledge as a process. The latter on the one hand concentrates on the flows of knowledge between individuals and on the other hand on processes of jointly creating and retrieving knowledge in a collective of individuals which is conceptualized for example by the transactive memory system approach (Wegner 1986).

How can these processes be described? What kinds of relationships between individuals are needed in order to encourage these knowledge processes or make them possible? How can hidden social structures in organizations be detected which could be supported by organizational measures and instruments (e.g., the selection of members for projects and work groups, the adaptation of roles, the building of communities, the organization of meetings to name a few)? In the following, the main forms and application areas of network analysis are reviewed in order to judge the possible contributions of this instrument to answer these questions (for a detailed analysis see Pappi 1987a).

Network analysis as applied in social sciences is based on two research traditions: sociometrics (e.g., Moreno 1967, cf. Pappi 1987a, 11) and social anthropology (e.g., Mitchell 1969, cf. Pappi 1987a, 11). It can be used in general to study both, micro and macro structures of social networks and to analyze relationships e.g., between individuals, positions, groups, communities or organizations. A social network is defined as a set of social entities (such as individuals, groups, organizations) which are connected by a set of relationships of a certain type.

Sociologists distinguish between *partial networks* – in which only relationships of a certain type are considered, and *total networks* – all kinds of relationships are

436. http://www.mindjet.de

considered. They also differentiate *wholesome networks* in which a multitude of social entities and their relationships are considered and so-called *ego-centric networks* in which one social entity with its relationships to other entities is focused.

The combination of wholesome and partial network analysis seems to be the most promising area to be applied in the field of KM. This is due to the idea that (a) only those relationships have to be considered which support knowledge processes (therefore partial network) and (b) the unit of analysis (= the social entities) could either be (a group of) individuals, groups, communities or other organizational units, such as departments. In either case, it is the "general picture" of the relationships between these entities that is of interest to KM, not only those of one single entity (therefore wholesome network). Network analysis can be used to study the following three perspectives of phenomena of grouping (Pappi 1987a, 15):

Structured order. This perspective is used to interpret the individual behavior as an action appropriate for the position the individual holds. In KM, this perspective stands for the formal structural organization (e.g., hierarchy, positions, ranks).

Categorical order. This perspective is used to interpret the intended behavior as a social stereotype of class, race, ethnic group etc. Also, this perspective could be used to study the effects of different "business-specific stereotypes", such as roles (e.g., technical experts and salespeople, novices and experts) in KM.

Personal order. This perspective is used to interpret the individual behavior as depending on personal relationships to other individuals and, moreover, on the "transitive" relationships which these "other individuals" have in turn. This can directly be applied to knowledge management.

Formally, social networks are represented by graphs. The knots represent the social entities and the edges represent the relationships. Formal characteristics of relationships are:

- *reflexivity:* determines whether or not a social entity chose itself ("self choice"),
- *symmetry:* determines whether a relationship is reciprocal (ego chooses alter and alter chooses ego),
- *transitivity:* determines whether a relationship from a to b and one from b to c imply a relationship from a to c,
- *valued graphs:* are graphs the relationships of which carry values such as intensity, number and duration of relationships.

With respect to the content, the following types of relationships have been investigated so far (Knoke/Kuklinski 1982, cf. Pappi 1987a, 16): transactions in which goods or services are exchanged; communication; boundary penetrating relations, e.g., between organizations; instrumental relationships: development of contacts to achieve goals; emotional relationships (e.g., the so-called socio-metric choice); authority or power relationships; family relationships.

Pappi suggests the following classification of relationships (Pappi 1987a, 17f):

1. **Potential for interactions:**
   - *objective*: opportunities for interaction, e.g., membership in groups, communities, supervisory boards; dependencies: if one social entity is interested in something another social entity controls; measurable in number of opportunities, intensity of dependencies,
   - *subjective*: socio-metric choices, normative expectations; measurable in intensity of choice,
2. **Actual interactions:** (measurable in number)
   - communication; measurable in number,
   - transaction: exchange of goods and services,
   - influential interactions,
   - other interactions: private contacts, etc.
3. **Permanent social relationships:** (measurable in durability)
   - friendship relationships,
   - role structures.

Figure B-46 shows a number of instruments and methods for network analysis classified according to the type of relationships and the unit of analysis.

relation		unit of analysis: one social entity	partial net	all social entities
one net	direct relation	popularity	neighbourhood	dense census of triads
one net	connected relation	prestige	clique	connection
one net / many nets	pattern of direct relation	social distance	position	picture structure
many nets	linked relation	multiplexity of local roles	aggregated local roles	role structure

FIGURE B-46. Typology of methods of network analysis interesting for KM[437]

Social network analysis has been repeatedly proposed as an instrument for KM (e.g., Zack 2000) and is definitely a promising direction on an agenda for future KM research and practice. Network analysis can for example be used to identify informal networks which then can be aligned in order to better support business or, in this case, KM goals (e.g., Krackhardt/Hanson 1993). Making informal networks visible can help to found communities which are open to be joined by new members and thus avoid a number of problems that informal, unidentified networks often have, e.g., holes in the network, fragile structures, so-called “bow ties” where the network is dependent on a single employee (Krackhardt/Hanson 1993, 110f).

437. This figure is based on Pappi 1987a, 26. Areas interesting for knowledge management are highlighted.

The following examples show in which KM-related scenarios network analysis has already been successfully applied (Krackhardt/Hanson 1993, 106):

Advice networks. An advice network reveals the experts in an organization as it asks whom employees contact when they need help or advice. These maps seem to be useful when a company considers routine changes.

Trust networks. This type of networks shows the strong tie relationships in an organization as it asks whom employees would reveal their concerns about work issues to. These maps seem to help when implementing a major change or experiencing a crisis.

Communication networks. A communication network simply analyzes whom employees frequently talk to and can reveal gaps and inefficiencies in the information flow. These maps should be considered when productivity is low.

These examples show the variety of application scenarios thinkable for network analysis to help identify networks that can be fostered and better aligned with the organization's knowledge strategy.

6.7 Résumé

This chapter discussed the multi-faceted organizational design of a KM initiative. Generally, the organizational design of a KM initiative and the organizational instruments used to implement it rely on the solid, mature and extensive foundation of the literature on organization science. A complete review seemed impossible because of the enormous number of approaches. Thus, the focus was on selected aspects that seemed to matter most for a KM initiative.

The chapter started with a comprehensive *model of the tasks and flows of knowledge management* which gave an overview of the target system for organizational instruments and measures and connects this chapter with other interventions[438] and the development of a KM strategy[439].

Then, the *structural organization* of a KM initiative was reviewed. The institutionalization of a separate organizational unit responsible for KM was discussed. New roles and collectives of employees were reviewed that have mushroomed with the advent of KM in the organizations. As the interviews preceding the empirical study have shown, so far most of the organizations have not implemented all or even a substantial part of these KM roles. In order to get comparable results across the organizations and not to confuse the respondents with the minor differences between several of these roles, the following three roles will be used in the empirical study:

- *knowledge manager* (CKO) or knowledge integrator,

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438. e.g., ICT instruments, see chapter 7 - "Systems" on page 273.
439. See chapter 5 - "Strategy" on page 93.

- *subject matter specialist*,
- *participant/author*.

After definition, classification and detailed description of the most widely discussed *instruments* applied in KM initiatives, the next section was focused on the *process organization* of knowledge management and reviewed selected KM tasks that deal with, involve or are supported by KMS. This restriction was again due to the abundance of knowledge-related tasks that are described in the literature. The KM tasks that will be used in the empirical study had to be reworded and selected due to the results of several pretests with knowledge managers:

- knowledge identification,
- acquisition of external knowledge,
- release of knowledge elements (formal approval of institutionalization),
- storing of knowledge elements,
- integration of knowledge into existing structure (knowledge classification),
- updating/extending of existing knowledge structure (ontology),
- knowledge distribution,
- knowledge quality management,
- refinement, repackaging of knowledge,
- knowledge deletion, archiving,
- knowledge selling.

Also, process-oriented knowledge management was discussed and the differences between knowledge-intensive business processes, knowledge processes and knowledge management processes were shown. Process orientation will be included into the empirical study with the help of one question about the scope of the organization's KM initiative. Respondents will be asked to report the number of business processes their KM initiative targets. Apart from this basic question, the pretests and also the interviews have shown that most of the organizations so far do not integrate KM related tasks, roles and instruments with business process management in their KM initiative. The relationships between these two concepts will be analyzed in detail as part of a subsequent study on the basis of interviews with selected respondents and will not be reported in this book.

Also, the notion of organizational culture was analyzed. On the one hand, the organizational culture has to be considered in the design of a KM initiative, on the other hand to change the organizational culture might be a goal of a KM initiative in its own right. The focus was set on the dimension *willingness to share knowledge* which will be investigated with the help of a set of statements describing:

- mutual understanding of work groups,
- mutual trust of work groups,
- mutual influence of work groups,
- mutual support of work groups,
- communication between work groups,

- help within work groups,
- willingness to learn,
- communication within work groups,
- existence of incentive systems for knowledge sharing,
- approval/acknowledgement of cooperative behavior,
- informal exchange of ideas (e.g., in breaks, at company events, private).

The selection of aspects of the organizational design of a KM initiative left out a number of other possible interventions into an organization's way of handling knowledge. Some of these other interventions were briefly sketched out, e.g., the architecture of office space, recruitment of experts or therapeutic interventions.

Finally, the specifics of *modeling* as part of KM initiatives were discussed. The four perspectives process, person, topic and ICT resources were distinguished. A large number of modeling techniques and methods already exists for each of these perspectives. Selected process modeling, activity modeling, knowledge modeling and person modeling techniques and methods were discussed with respect to their potentials for KM. Their combination is still a challenge for KM initiatives. Whereas KM initiatives with a focus on codification concentrate on the ICT resources and the topic perspectives, personalization efforts rather model person and topic. However, in order to ripe the potentials of KM, processes, persons, ICT resources and topics have to be jointly considered before KMS are implemented. The investigation now turns to KMS, their roots, contents, functions and architectures.