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Knowledge Media: An Innovative Concept and Technology for Knowledge Manage- ment in the Information Age

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Knowledge has become the most important resource in many organisations. The success of an organisation depends on its ability to transform the personal knowledge of employees, as well as knowledge stored in handbooks and other documents into organisational knowledge widely available according to special needs. In order to achieve this, innovative knowledge management concepts as well as technical platforms are required. Such platforms should provide on the one hand an integrated support for the representation, management and dissemination of knowledge in changing internal and external structures. On the other hand they should provide support for the dissemination and reproduction of knowledge according to needs of different user groups in enterprises.

Recent developments in information and communication technologies, and especially their convergence, opens unprecedented opportunities for redesigning and providing appropriate support for knowledge management. Information is now available on an interactive and ubiquitous carrier. In this paper we will present knowledge media - a new concept and technical solution for the management of knowledge by using innovative information and communication technology. In addition we will describe results from its application to management processes.

INTRODUCTION

It is nowadays widely agreed that knowledge has become the most important resource in the information age. Knowledge as a key factor is penetrating more and more aspects of business. The examples of the companies Microsoft and Amazon, show that the marketplace value of a company depends increasingly on its knowledge or intangible intellectual assets and on its ability to transform those assets into revenues [Edvinsson and Sullivan 96]. The success of an organisation in a global and uncertain market is also directly related to its ability to generate efficiently intangible assets. This includes the transformation of tacit knowledge of employees as well as knowledge locally available in handbooks or documents into organisational knowledge and to channel its usage towards producing innovations and greater profitability.

Knowledge management comprises all activities necessary to discover, acquire, store, manage, develop, disseminate and use knowledge [Probst, Raub and Romhardt, 97]. As such it is not a new activity. In the past, organisations have at least implicitly always striven to keep and manage knowledge. Examples of such activities are the creation of diverse handbooks or programs for training on the job. But this activities have been done from an organisational point of view and not in order to manage a key competitive factor. Nowadays, under the pressure of a global and uncertain market and increasing dynamics of external and internal change knowledge management is on the forefront of organisation's activities. As knowledge or to know is the privilege of human beings knowledge management in particular means the management of the knowledge creation spiral proposed by [Nonaka, 91]. Its aim is an effective and efficient creation, collection, management and usage of knowledge in order to increase the competitiveness of the company.

Innovative information and communication technology is used as an enabler to achieve this goal. As a result of the convergence of information and communication technology (ICT) we received an interactive carrier of information, the fundament of knowledge [Schmid, 98]. In addition ICT represents for the first time a carrier, which is capable to mimic human intelligence, i.e. to "reason" by himself [Schmid, 98]. Already available technologies as expert systems or intelligent agents [Brenner, Zarnekow and Wittig, 98] have demonstrated, how human reasoning can to some extent be transferred to a machine. Both mentioned developments enable the implementation of artificial knowledge management systems, which enhance and empower human knowledge creation and management in a complementary way.

First systems as Organisational Memory Information Systems (OMIS) or Intra- and Extranets for supporting knowledge management are already available. Despite, the fact that such systems have increased information availability they still do not use the whole potential of innovative ICT. The concepts and solutions concentrate on institutionalised, i.e. externalised knowledge leaving the fluid tacit knowledge of humans outside of the system. In addition there is no concern for the processes which are part of knowledge creation and usage. Thus existing solutions apply the conventional paper-based knowledge management concepts without their adoption to the potentials of the new medium. Such systems furthermore focus on some aspects of knowledge management or on knowledge management in specific areas of the organisation. As a result they do not provide a generic solution and do not provide support for knowledge combination across organisational boundaries as departments or functional areas.

In order to use the potential of innovative ICT for efficient knowledge management we need new concepts and systems, which follow a holistic approach and support a symbioses between computer based and human knowledge management. In this paper we will introduce knowledge media - a new holistic concept and technical solution for the management of knowledge

which fully takes advantage of the potentials of new ICT. In addition we will describe results from its application to management processes.

The content of the paper is divided in sections as follows: In section 2 implicit, explicit knowledge and the knowledge generating cycle will be explained. Based on it in section 3 the requirements on innovative concepts and information systems for knowledge management will be deduced. Section 4 contains a detailed description of knowledge media. In section 5 the concept is applied in order to analyse knowledge management and to design a knowledge management system for corporate planning processes.

TACIT, EXPLICIT KNOWLEDGE AND THE KNOWLEDGE GENERATION CYCLE IN COMPANIES

“Understanding how knowledge is developed in a company is a precondition to manage knowledge and intellectual capital” [von Krogh and Roos, 96]. Therefore, we first explain knowledge and the knowledge generation cycle in companies. This will be the base to define requirements on information systems supporting knowledge management.

Definition and Classification of Knowledge

To know i.e. knowledge is a feature of human beings. We define knowledge as the internal state of an agent following the acquisition and processing of information [Schmid, 98]. An agent can be a human being, storing and processing information in his brain, or an abstract machine including devices to store and process information [Schmid, 98].

Human knowledge can be divided in two parts: tacit and explicit knowledge. Following both type of knowledge are explained in accordance with Nonaka [Nonaka, 91].

Tacit knowledge is person dependent and comprises the subjective insights, intuitions and hunches of individuals. Thus, it is hard to formalise and, therefore, difficult to communicate to others. Tacit knowledge is also deeply rooted in an individual's commitment to a specific context as a craft or profession, a particular technology or product market, or the activities of a workgroup or team. With other words knowledge is deeply ingrained into the context, i.e. the owners view and imagination of the world and into his experience, which is previously acquired knowledge. Therefore knowledge is a combination of information, contexts and experiences [Harris, 96]. Thereby, context always refers to a certain world and defines therefore the meaning of knowledge [Conklin, 96]. To transfer knowledge, the receiver's context and experience must be taken into account. If it differs from the context of the sender the transferred knowledge might be misunderstood. In a community of human and artificial agents a common context, i.e. an intention to achieve a common understanding of the world exists.

Explicit knowledge is coded, i.e. externalised tacit knowledge. It consists of two components: a language, information and a carrier. The language is used to express and code knowledge. Information is coded externalised knowledge. It is potential knowledge, which is realised when information is combined with context and experience of humans to new tacit knowledge [Schmid, 98]. The carrier is capable to incorporate coded knowledge and to store, preserve and transport knowledge through space and time independent of its human creators. During history several type of carriers have been used as for example paper or computers [Schmid, 98].

Examples of explicit knowledge are documents in enterprises describing projects or other experiences. Compared to tacit knowledge explicit knowledge is formal, systematic and available on a carrier, which is independent of humans. For this reason, it can be easily communicated, shared, reused and preserved even if its human creator is not available any more. The usefulness of explicit knowledge depends on its completeness. If explicit knowledge does not include a description of the context in which it was created it can easily mislead receivers [Conklin, 96].

Organisational knowledge, i.e. the knowledge of an enterprise is the entity of its explicit knowledge and the tacit knowledge of its employees. The aim of knowledge management is to balance those two types of knowledge and to channel them towards greater innovation and profitability of the company. In particular this means on the one hand to enable externalisation of tacit knowledge into explicit knowledge and on the other hand to use explicit knowledge to enhance existing and to create new tacit knowledge. With other words it means to manage the knowledge creation spiral, which is explained in more detail in the next section.

The Knowledge Creation Cycle

According to [Nonaka, 91] there are four basic patterns of creating knowledge:

- **From Tacit to Tacit** – when individuals share knowledge directly through observation or imitation without coding it on an external carrier.
- **From Explicit to Explicit** – already available coded, discrete pieces of knowledge can be combined by individuals to new explicit knowledge.
- **From Tacit to Explicit** – individual knowledge can be externalised, i.e. coded on an independent carrier to explicit knowledge.
- **From Explicit to Tacit** – explicit knowledge can be internalised by individuals to new tacit knowledge. Individuals use explicit knowledge to broaden, extend and reframe their own tacit knowledge.

Creating tacit from tacit knowledge is institutionalised in all companies in approaches as learning by doing and learning-on-the-job. In a way transfer of knowledge through personal contact can even not be prevented. Employees can acquire new knowledge by observing or talking to other employees. With some exceptions, the creation of tacit from tacit knowledge basically requires that involved carrier of knowledge are available at the same place at the same time. Tacit knowledge stays with humans and is only available to organisations as long as the human carrier is also there.

One aim of knowledge management is to keep and transform individual knowledge to organisational knowledge. Thus, great attention is nowadays paid to the process of creation, management, and dissemination of explicit knowledge. With reference to Nonaka [Nonaka, 91] the process of knowledge creation in organisations is a set of interwoven processes, which can summarised as follows (c.f. 1):

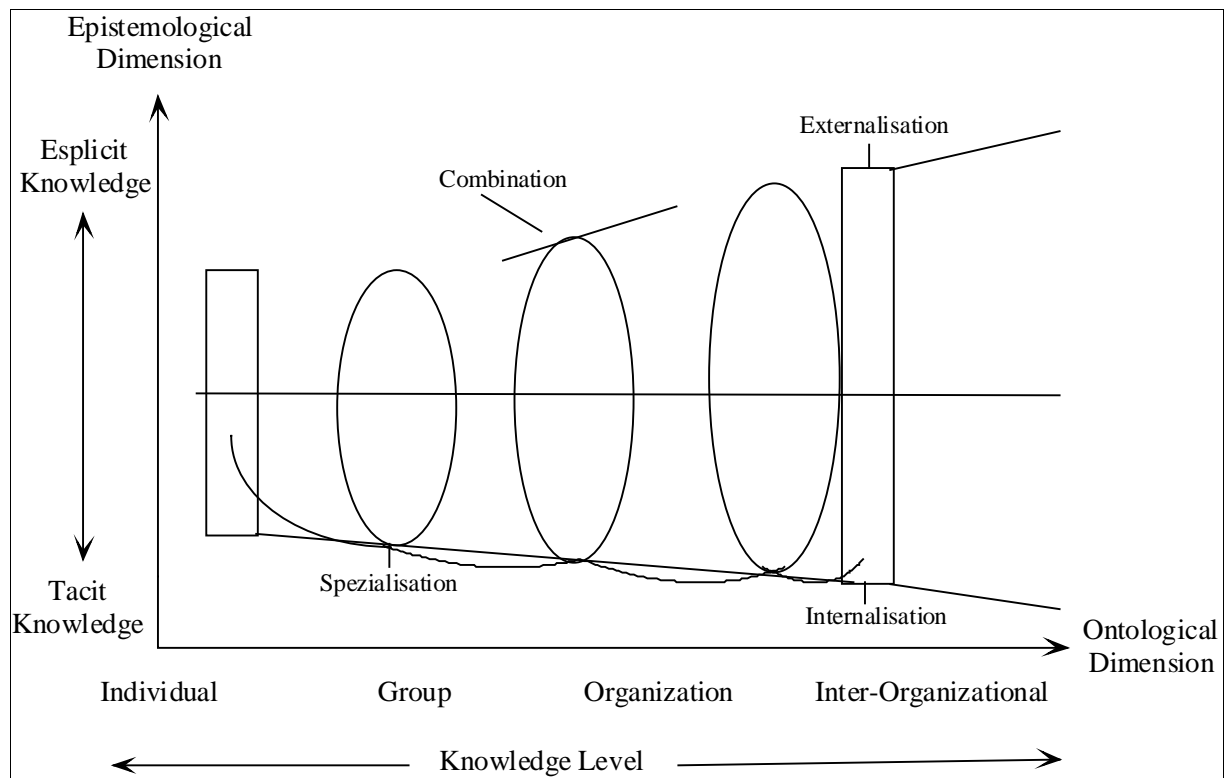


Fig. 1: *The Knowledge Creation Spiral [Nonaka, 91]*

Organisational knowledge is created through a continuous dialog between tacit and explicit knowledge. Starting point is always tacit knowledge, which is created by employees and externalised on an external carrier as paper or computers. Thereby moving from the tacit to explicit knowledge is the articulation of one's vision of the world. Thus explicit knowledge represents a specific view on a given world, which was created within a given context.

While new knowledge is developed by individuals, organisations play a critical role in articulating and amplifying that knowledge. In its explicit form knowledge can further be combined with other explicit knowledge to new one. At the end of the process is the internalisation of explicit knowledge to new tacit knowledge.

From the process point of view the knowledge creation spiral is a set of interwoven processes of knowledge creation, externalisation, usage, combination and internalisation, which are defined around a given kernel of explicit knowledge. The processes are performed by human or software agents parallel and in different combinations. After a critical mass of new or redefined knowledge is created they result in a new basic kernel of organisational knowledge.

The knowledge creation circle has furthermore two dimensions (c.f. 1): the epistemological dimension, representing the fluid tacit part of knowledge and an ontological dimension representing the language fundament of knowledge. Languageing, i.e. creating words for concepts is the basic mean for externalisation of knowledge. Without language, knowledge could not flow from one person to another person within an organisation. New experiences or concepts are expressed in new words [von Krogh and Roos, 96]. These words are then shared in a group or community, might even become corporate terminology or even characterise the communication with other enterprises.

Every company has its own unique set of concepts and phrases as well as usage patterns for them [von Krogh and Roos, 96]. Language usually is defined within a context and within a group of persons i.e. community. Thus, even though there might be a corporate terminology

usually each part of the company might have also its own specific language. Thus knowledge management has to consider the specific features of communities but at the same time providing support for integrated views.

Requirements for Knowledge Management Information Systems

As mentioned above the fundament of knowledge is information – the coded form of externalised knowledge. ICT is the basic enabler of efficient management of information. But what is necessary in order to use it also for the support of efficient management of knowledge ?

Out of the above described features of knowledge as well as of the knowledge creation spiral in enterprises the following requirements on information systems for the support of knowledge management can be deduced:

- As organisational knowledge is a combination of explicit and tacit knowledge, information systems for supporting knowledge management should be an integrated solution supporting a smooth transfer from tacit to explicit and from explicit to tacit knowledge.
- They should consider communities and provide specialised and customised solutions for communities but at the same time enable communication and transfer of knowledge between communities.
- They should support “linguaging” and relate language to content of organisational knowledge.
- They should provide efficiently facilitate all processes as knowledge creation, knowledge externalisation and knowledge usage as retrieval, combination and transportation.

KNOWLEDGE MANAGEMENT INFORMATION SYSTEMS – WHERE DO WE STAND NOW ?

ICT offers a new carrier for knowledge with unprecedented opportunities for supporting knowledge management. In this section first we will discuss the potentials of ICT to improve and to meet the above requirements of knowledge management. Then we will give a short overview on existing information systems for knowledge management and will compare them against the requirements.

The Potentials of innovative ICT for Knowledge Management

The potentials of innovative ICT for supporting knowledge management can be summarised as follows [Lechner et.al., 98]:

- **Ubiquity of information and unlimited access:** As a result of the convergence of information and communication technology we received an interactive carrier of information, which provides unlimited access to information by bridging time and space barriers [Schmid, 98]. As a consequence the fundament for knowledge creation can easily be distributed and made available to all employees of a company.
- **An interactive and “intelligent” carrier:** In ICT we have for the first time a carrier, which is capable to mimic human intelligence, i.e. to “reason” by himself [Schmid, 98]. Already available technologies as expert systems or intelligent agents [Brenner, Zarnekow

and Wittig, 98] have demonstrated, how human reasoning can to some extent be transferred to a machine. The new carrier can even perform certain tasks even better than humans. Humans are better to understand knowledge, to interpret it within a broader context, to combine it with other type of information or to synthesise various unstructured forms of knowledge. Compared to that innovative ICT is more capable to capture, transform and distribute highly structured knowledge that changes rapidly [Davenport, 98]. Given this mixture of skills and the interwoven types of knowledge in the knowledge creation circle, hybrid knowledge management environments can be created in which humans and computers create and manage knowledge by complementing each other [Schmid, 98], [Davenport, 98].

- **Effectiveness and efficiency of knowledge management:** The costs of establishing knowledge repositories based on conventional carriers as paper and keeping them up to date are huge. A repository of organisational knowledge, which is interwoven with the community generating the knowledge collected in the repository and relying on this repository as knowledge base provides an efficient means to foster knowledge externalisation and to use knowledge. Moreover, due to ubiquity of the carrier changes in the repository take immediately organisation-wide or even towards business partners ensuring hereby effectiveness of the repository.
- **Organisation and Navigation:** The new carrier for coded knowledge provide convenient ways to access the knowledge or to search for knowledge as well as manifold way to relate knowledge. Several different organisational views can be laid upon the contents presented in a repository of organisational knowledge expressing different systematisation, organisation and representation paradigms. Thus, there is no need to stick with one predominant organisation paradigm, or with mainly linear orderings of contents as media on traditional carriers have to do. In addition efficient means are available to customise i.e. to adopt the repository to the needs of specific communities.

Overview of existing Knowledge Management Information Systems

The growing importance of knowledge and knowledge management has given rise to the development of information systems for the support of knowledge management. The available systems can be classified in two groups: tools or systems aiming the support of management of individual knowledge and information systems for supporting management of organisational knowledge. The focus of this paper will be on the second category. Systems belonging to this category can be further divided in basic technologies as document management systems and Groupware or Computer Supported Cooperative Work (CSCW) as well as systems that are specially dedicated to supporting knowledge management as organisational memory and Intranet/Extranet Systems.

Document Management Systems (DMS)

Under DMS we understand information systems that provide support for an efficient, database oriented storage, management and accessibility of documents. At their early stage of development DMS were primarily concerned with providing online access to documents stored as bit-mapped images. Later on they moved to “compound document management” technology, which addresses managing document content at the level of smaller components. In addition DMS are often connected to workflow management systems (WFMS) [Marshak, 94], which coordinate the flow of documents according to given process scripts. In both forms DMS have transferred the concepts of management of structured information to unstructured information as documents – they provide access to already available documents without further adding

value to them. Especially the lack of management of context of the documents prevents in many situations a effective usage of their content [Conkin, 96].

Groupware

Groupware are information systems supporting the co-ordination of co-operative work. One example of a well known Groupware products is Lotus/Notes. Groupware is designed and basically used for informal communication during co-operation. It captures and creates a repository of the unstructured pieces of information created by a team during their common work. Even though groupware has enhanced team-work, it still is not a sufficient solution for knowledge management. Compared to DMS they focus on unstructured information and provide a common team repository for all kind of such information as for example: mails, comments drafts of papers and their final versions, ideas, and discussions. Such repositories are very valuable at the moment of working but are less appropriate for a durable knowledge repository. The basically do not capture the context and there is no added-value summary of the created knowledge. They just provide a collection of pieces of information, which make sense only for the involved persons. Thus groupware tend to make informal knowledge explicit, but they generally fail to create coherent team or organisational knowledge [Conklin, 96].

Organisational Memory Information Systems (OMIS)

“Memory may be defined as the faculty of retaining and recalling things past.” [Corbett, 97]. Organisational memory is *“stored information from an organisation’s history that can be brought to bear at present decisions”* through a social process of articulating, exchanging and sharing information leading to a shared model or interpretation of the world. Thus organisational memory is the means by which organisational knowledge is transferred from the past to the present. Information systems, which support the creation and management of organisational memory are called Organisational Memory Information Systems. In order to achieve their goal OMIS must provide support for the storage and management of information beyond DMS and database systems. In particular OMIS must integrate in addition to documents and structured information its context as well as unstructured information. In the literature several OMIS have been described [Morrison, 97]. The basic features of available OMIS can be summarised as follows: they are developed for a special application area (see for example [Ackjermann, 94] and thus are dedicated to a specific type of information as for example process knowledge, knowledge created during work on projects or enhanced DMS. There is no integrated support for the processes necessary for the creation of memory and its dissemination. Process support is mostly considered for internal management processes necessary to maintain the content of the OMIS. Thus such systems mostly fail as they are not a natural extension of the knowledge creating process but require additional efforts, which do not provide immediate value [Conklin, 96], [Ackermann, ^94].

Intranets and Extranets

After the success of Internet as a world-wide data highway, the potentials of the Internet technology and WWW have been discovered for the management of information and knowledge within organisations as well between organisations. As a result Intra- and Extranets appeared as a new type of knowledge management information systems. Intra- and Extranets apply the basic principles of DMS and OMIS systems, can be enhanced with groupware functionality and have brought the multi-media aspect to knowledge management. They respectively have the same drawback as the above mentioned systems.

Weaknesses of Knowledge Management Information Systems

The above described currently available information systems for knowledge management have to a great extent improved information availability but have not reached the goal to provide an efficient support for knowledge management. The major weaknesses can be summarised as follows:

- The concepts and solutions concentrate on institutionalised, i.e. externalised knowledge leaving the fluid tacit knowledge of humans and the human carriers outside of the system. Thus an important integral part of organisational knowledge is not integrated in the system. In addition the potential of the system to empower human reasoning is not used [Schmid, 98], [Davenport, 98].
- Externalised knowledge is considered without the context within which it was created. This limits its reusability to employees, which have a background of the context [Conklin, 96].
- The systems are not designed to be an integral part of knowledge creation. Important processes as knowledge externalisation do not flow naturally, i.e. without breaks in the system. In order to receive added value of the stored information, additional tasks have to be performed, which do not provide immediate value and therefore are often omitted even though they may be of importance in the mid or long term [Conkin, 96].
- The systems do not support languaging. The meaning of the terms used as part of structured or unstructured information is not explicitly stored in the system. As the meaning of words might change over time the stored knowledge might be misunderstood.
- Such systems furthermore focus on knowledge management within a specific area of application. As a result they do not provide a generic solution and do not provide support for knowledge combination across organisational boundaries as departments or functional areas.

Thus existing solutions apply the conventional paper-based knowledge management concepts without their adoption to the potentials of the new medium. In order to take full advantage of the potentials of innovative ICT a holistic approach is required which on the one hand enables a mapping of the whole knowledge creating spiral into the system and on the other side enables a symbioses between human and artificial knowledge carries. In the following section we will present knowledge media a holistic approach for knowledge management in the information age.

KNOWLEDGE MEDIA - AN INNOVATIVE CONCEPT AND TECHNOLOGY FOR KNOWLEDGE MANAGEMENT

In accordance with [Schmid 98] we define knowledge media (KM) as information spaces, which based on innovative ICT support information exchange within a community consisting of human and artificial agents. KM can also be described as entities of distributed information and knowledge sources and agents who create new knowledge or use existing knowledge. Thus KM provide integrated spaces of tacit and externalised knowledge, language and meaning.

The concept of KM is instantiated from a generic concept of computational media [Lechner and Schmid, 98]. The computational media metaphor is a first step towards building media based on the new interactive and ubiquitous carrier. It provides a general model, which de-

scribes media as a multi-agent system in terms of computer science. Thus it provides a concept, which can be implemented by using innovative ICT.

Following the basic components of KM will be described based on [Schmid, 98] (c.f. 2):

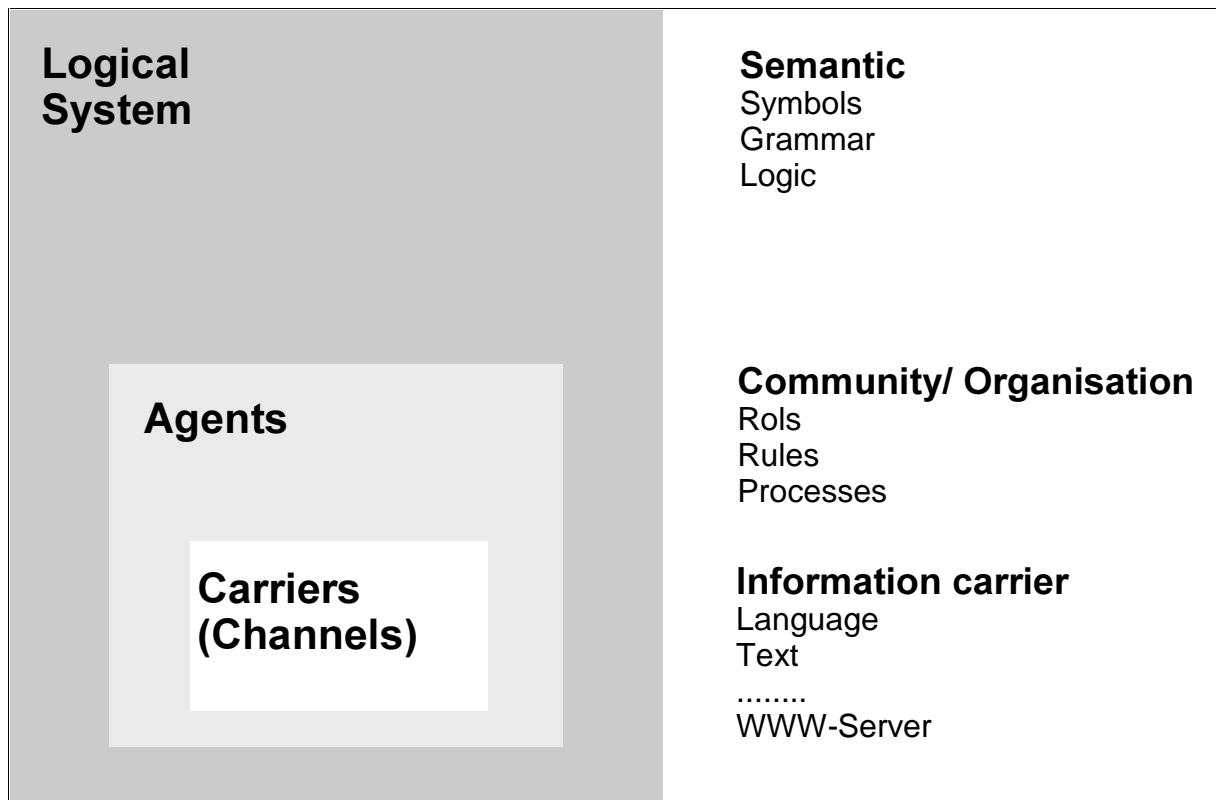


Fig. 2: Basic components of KM

Channels

Channels are a system of connections and transportation means for information between them. Channels are capable of taking over explicit i.e. coded knowledge and to preserve and transport it over time and space barriers. Thus they form communication systems, which are responsible for the transportation of explicit knowledge. Yet, channels are passive parts of KM. They are activated through agents.

Information Objects

Externalised knowledge can be stored on active or passive carriers. Examples for passive carriers are books, paper etc. Under information objects, we understand active carriers of pieces of explicit knowledge, which are based on information technology. Most prevailing information objects in companies are for example electronic documents. Other forms of information objects are contributions to discussions and thesaurus. Information Objects are made transportable through their connections to channels.

We distinguish two types of information objects: basic terminology used and defined by a community on the one hand and complex information objects on the other hand. The terminology represents the result of languaging and is a model of the world observed by a specific community. Basic pieces of knowledge can be used in order to construct more complex in-

formation objects. Information objects of a KM are enhancing human memory by storing and providing qualified access to huge quantities of knowledge.

Besides the core part of externalised knowledge information objects of a KM are extended with context in form of a meta-description and references to processes in which they have taken part.

Agents

Agents are human representatives or software systems, which are grouped in communities around specific KM and are responsible for knowledge creation and usage. A group of agents, which follow a common goal and have common interests form a community. Communities apply to specific organisational structure, which defines possible roles of agents and regulates the processes for knowledge generation and usage. Agents can take over different rules and can have artificial representatives in the KM.

Organisational Structure

Knowledge creation, management and usage happens within a given organisational structure. Agents take over specific roles which require certain capabilities from them and impose certain obligations and rights. The second component of organisational structure are protocols. Under protocols we understand all processes, which are necessary for the correct functioning of a KM. Protocols are defined over roles of agents and follow predefined rules, which regulate and co-ordinate the interaction of agents in order to achieve a common goal.

Logical system

As mentioned above language is the necessary prerequisite for the externalisation and exchange of knowledge. The logical system of a knowledge medium denotes the language, which is used in order to code knowledge. It comprises syntax and semantics. The syntax defines the language, the grammar and the rules according to which correct sentences can be defined in the chosen language. The syntax must be implementable on the carrier and applied by the agents of the KM. Semantic defines the meaning of the used language constructs and has to be clearly defined for the community using the language. Semantics is not included in syntax but is given through the reference to real world objects.

In a knowledge medium we want to take advantage of the ability of the new carrier to enhance human intelligence and reasoning. In order to achieve a symbioses of artificial and humans agents, the language should on the one hand be understandable for persons on the other hand for computers. Thus the language has to have a representation in machine readable form. The machine readable part is providing a meta-layer over the content of the knowledge medium enabling classification and structuring of knowledge as well as allowing for an automatical retrieval and combination of explicit knowledge. With the two representation forms the logical system is the binding element between humans agents and machines or between tacit and explicit knowledge.

In addition to representing the knowledge of a KM, the meta-layer includes meta-information as for example author, address of receiver or sender, which is necessary for the control of communication as well as knowledge creation and management processes.

The content of the KM, created using the chosen language is a representation of the world observed by the community. One particular world can be modelled by different communities. If a semantic connection between the languages of such KM can be established, than a knowledge exchange between them can be facilitated by automatical translation of language concepts in each other.

Relationship between KM components

The above described components of a KM are interwoven with each other and form an entity of human and artificial agents connected through a semantic space facilitating exchange of knowledge. Taken together they furthermore represent a complete mapping of the real world environment of knowledge creation, management and usage, i.e. of the knowledge creation spiral, into an artificial world based on ICT, which is capable to mimic human knowledge creation and management. Thus it provides not only an efficient storage of external knowledge, but also the related context and processes.

APPLICATION OF THE KNOWLEDGE MEDIA CONCEPT IN CORPORATE PLANNING

The concept of knowledge media is a promising approach to tackle knowledge management in management processes. It has been applied for this purpose in two projects at the Institute for Media and Communications Management: 1) to analyse knowledge management in executive processes in general in the project Competence Center Enterprise Knowledge Media and 2) for redesign of corporate planning processes in the international ESPRIT-Project "Integrated Business Information Systems (IBIS)". Following the resulting system for supporting corporate planning processes will be described.

Corporate planning is an intensive knowledge creation and management process. Its aim is the development of future directions for the development of the company in form of plans. The plans are the control criteria for future actions. In order to define plans on the one hand the environment of the enterprise is scanned in order to detect possible chances and threads. On the other hand the internal state of the enterprise is evaluated in order to get aware of strength and weakness. Therefore during both processes knowledge of great importance for the company is created, externalised and summarised to new knowledge. For example in sales planning sales persons usually report about experiences with customers and give estimations of the market trends for the next year. The analyst department creates prognoses and scenarios concerning possible developments of the environment. In the production departments ideas for improvement of existing or for development of new products are evaluated for further consideration. In short corporate planning is a institutionalised process for knowledge creation and exchange.

Despite the importance of knowledge which is created during planning there are few enterprises, which apply knowledge management concepts and systems in planning. Thus often valuable knowledge is lost for the organisation [Stanoevska-Slabeva, 97]. This is especially enforced by the distributed character of corporate planning processes.

Planning activities happen within groups of employees or departments, which use their own terminology and contribute to planning from the groups point of view and context. The interdependency of groups and departments requires an intensive exchange of information and knowledge between them. These processes of knowledge exchange are formalised to a great extend and take place based on predefined quantitative forms. Thus a lot of information is lost along the process as there is no possibility to capture the context of the quantitative plans and the informal information flow within planning. Following a possible solution for supporting knowledge management in corporate planning based on experiences of the IBIS-project and by applying the concept of KM will be presented.

Agents within planning are the employees, which are involved in the planning process but also the ones who can contribute to planning as information or idea provider. In a broader sense the community involves also those who are responsible for fulfilling the plan and its

control. Agents i.e. planners play a certain role in the planning process. They are responsible for a certain topic as for example cost calculation and planning or strategic planning. In addition they are part of a given organisational structure and either report to the next hierarchical level or consolidate partial plans from other employees.

Information objects can be found in any form as for example: experience reports, tables with quantitative planning information databases with entries tracking customer activities and calendar, discussions, informal information flows through telephone or discussion and similar. Main drawback for any kind of knowledge management, is that there is no integrated storage and carrier for related information of all kinds.

Concerning quantitative planning information there is always also a dedicated quantitative terminology. It can be observed that terminology differs and that it is community dependent i.e. dependent on the context of planning departments or groups [Stanoevska-Slabeva, 97]. This was also one of the obstacles for integrating information systems as the process of developing a common terminology never ended. Thus a medium is required which can serve the special interest of the small groups but also can integrate them in so far as to enable the necessary information flow between them.

Based on the above findings a system with the following modules as a first step towards a knowledge medium in planning was developed within the IBIS project: In order to integrate related information integrated planning documents based as compound documents were designed. They consist of a container responsible for the co-ordination of the different parts and of quantitative information, qualitative information and descriptors (c.f. 3).

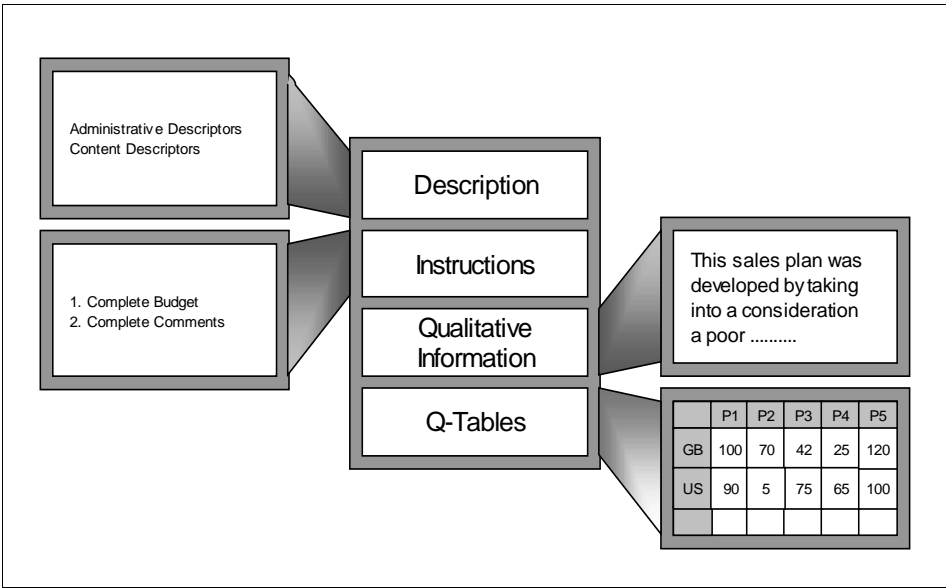


Fig. 3: *The Structure of an Intelligent Planning Document*

The descriptors are part of the logical system and represent the meta-information of the documents. As a logical system the Q-Calculus - a formalism for the representation and processing of quantitative information is used [Schmid et. al., 96]. The Q-Calculus is capable of representing quantitative terms as semantic nets according to predefined rules and to inference over them. For example from the semantical net comprising the definition of the term Return on Invest (ROI) the system is capable to deduce its definitorial parts and based on it to generate automatically procedures for calculating the number from given information. So the needed information can be calculated out of given information. In addition the semantic nets

also mark a possible retrieval path. For example if there is no information on ROI in total than it might be helpful to have information about its parts as income, costs and capital. Especially if this is given quantitative information even the procedures necessary to calculate the needed information is generated automatically. The needed information is combined in a flexible compound document (c.f. 3)

The documents are managed by a document management system, which provides intelligent search according to meta-descriptions as well as support for management and storage of the documents.

The agents are described in a organisational knowledge base. The descriptions concern the administrative information about agents as: name and address. In addition they refer to the organisational dependence of the agent. Special descriptions refer to their abilities.

Structured processes are supported through workflow technology, which co-ordinates the routing of documents according to predefined process scripts and systems supporting informal discussion.

CONCLUSION AND OUTLOOK

In the paper we first summarised the basic concepts of the knowledge creation spiral in organisations. Then we deduced the requirements to knowledge management information system, evaluated existing such systems and summarised their weaknesses. We then presented the concept of knowledge media as a holistic approach for knowledge management in enterprises. It proposes a symbioses between human and artificial carriers of knowledge in which the complementary capabilities of them are combined in a useful way. Thus compared to other approaches and systems for knowledge management KM adopts a holistic approach, which considers in an integrated way all aspects of the knowledge creation spiral: humans, processes, machines, tacit and explicit knowledge and its context. In the last section we presented the application of the concept in corporate planning processes. The resulting IBIS-system demonstrates how the concept of KM can be realised by a qualified integration of existing software systems. As a next step we plan to apply the KM-concept on other processes and to synthesise the results in a general methodology for the analysis of knowledge based processes and for implementation of KM.

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