Closing the Gap: From Nescience to Knowledge Management

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Abstract

Knowledge management (KM) systems aim at supporting knowledge workers in general and software engineers in particular. These tools help to elicit, structure, and retrieve knowledge. However, while KM systems are functional, they are not used in practice as effectively as possible as there is not much incentive for experts to share their expertise: the concrete need for knowledge is unclear as is the value/reward for knowledge entered into the system.

This paper proposes to enhance the KM process by accentuating the importance of nescience in information and knowledge-centric processes. A concrete concept is suggested proposing a question related system in the KM environment, which establishes need for answers and allows to establish a market for knowledge. Such a market guides the experts to donate knowledge that is currently most valuable in the user community. The effectiveness and efficiency of the new processes can be empirically evaluated by monitoring the activities of information seekers and experts in the KM system: the frequency of access and feedback of user satisfaction with the system.

1. Introduction

Knowledge management (KM) strategies become more and more important as researchers and managers detect the importance of information and knowledge as driving factors of the current economical system. Successful companies often show excellent skills in KM as well as *customer relation management* which is also partly depending on knowledge and information management.

Some argue, that KM is no new "invention" but rather a buzzword for a set of recycled strategies and systems [10]. For example, from a KM point of view, a computer supported cooperative work (CSCW) system could already be seen a specific part of a KM system, hence this aspect has to be analysed in more details. The importance of KM usually is out of discussion though, despite the broad possible definition of KM.

> "A software organizations main asset is its intellectual capital, as it is in sectors such as consulting, law, investment banking, and advertising. The major problem with intellectual capital is that it has legs and walks home every day. At the same rate experience walks out the door, inexperience walks in the door.
>
> [...]
>
> KM is unique because it focuses on the individual as an expert and as the bearer of important knowledge that he or she can systematically share with an organization." *Russ et.al. [8]*

So we will not discuss about terminology in the first place, as we believe, that KM is (if new or recycled) as a holistic approach an essential and eventually system-critical aspect in modern management and cooperative work. KM should be integrative part of any CSCW system. However, the target audience of system proposed in this paper goes beyond the specific domain of software development (engineering) and includes all areas of knowledge working.

Besides this general relationship between CSCW and KM systems, a new communication/question-based KM approach will suggested. This is particularly interesting as it would integrate seamlessly into CSCW/communication systems. This is an essential factor as Stewart et.al. analyze:

> "Unfortunately, contemporary technology for knowledge management is a hodgepodge of executive IS, group-support systems, intranets, decision-support systems, and knowledge-based systems." *Stewart et.al. [13]*

So all efforts that try to integrate systems (communication, collaboration, project management and knowledge

management) are a significant progress to the contemporary situation. Finally further perspectives like ideas about *artificial intelligence* and *intelligence amplifying* systems will be discussed, besides the possible risks of KM systems.

2. The Dissapointment of Knowledge Management

Knowledge Management is an important topic for universities as well as for companies and might create a huge increase in productivity of institutions. So what is *knowledge management*? One common definition is the following:

> "The objectives of knowledge management (KM) in an organisation are to promote knowledge growth, knowledge communication and knowledge preservation in the organisation. (in [5])"
> *L. Steels [12]*

Nevertheless traditional knowledge management concepts often show problems in acceptance of the end-users. There are several reasons for this:

- Knowledge aquisition is usually a "proactive" process. This means, that each expert user has to give input into the system whithout having an immediate use from the system.
- Even if knowledge topics are entered and managed properly, knowledge management systems often only help to provide a contact between the person who has the problem and the person who might find a solution. The solution itself often is not included in the system.
- A person who might solve a problem might feel not highly motivated in offering help as it (1) disturbs his normal activities and (2) he realizes no advantage for him- or herself.
- Information in knowledge management systems should be updated regularly to be useful. Considering the problems above, it seems clear that even this is usually not done regularly.

3. Crossing the Gap: Back to Nescience

The term *knowledge management* obviously suggests the necessity to deal with information and knowledge, but as often detected (and also discussed here), direct access to knowledge is difficult by many reasons. On the other hand, living in a *knowledge society* means, that development is driven by new detections/findings/research, new information, that needs to be processed and finally new knowledge to be created. But at the same moment, when knowledge is generated and applied (!) society proceeds one step higher in system complexity; the nescience, the insecurity increases, new problems arise, and generally spoken the system risk grows [6, 17].

Following those considerations, the new concept suggested here assumes an approach to the problem inspired by Willke [17].

> "The crisis of knowledge ist cognitively driven by the new relevance of nescience. Operationally it is driven by the necessity to make the right mistakes faster than the competitors to intensivate learning processes, what means developing expertise in handling nescience[1]."
> *Helmut Willke [17]*

According to the problems described above, a knowledge management system (KMS) as suggested here proceeds on an indirect path towards the acquisition of knowledge and should fulfill at least the following requirements:

- A *re-active process* is assumed to be more useful than a proactive process. The reason is, that people are easier to motivate to act, when they have a problem, not when having a (possible) solution. Especially when it is not clear that there is a reward for the knowledge added proactively.
- A KMS should not work simply as a medium to enable contacts between people who know and such who don't. Moreover it is desired to build a *knowledge repository* that keeps relevant information for more than a single usage case.
- Persons who have *relevant* knowledge must be motivated to provide this knowledge and share it with others.
- A KMS has to be a living system with frequent interaction. Hence it is useful to integrate the KMS into existing CSCW or communication systems.

Following these prepositions, the core idea of the suggested concept is to put the management of the nescience into the center of interest, or in other words: nescience can be expressed in the form of a *question*. This question shall be the starting point of the knowledge acquisition and management. Moreover, as described in [1] knowledge management should be a highly integrated task. So an implementation in CSCW applications can lead to synergic effects:

[1] The original citation is in German and is translated by the authors.

> "Coordination and collaboration support must be a first order citicen of KM [...] information retrieval and management systems must deeply be interwoven with the collaboration-oriented everyday work." *Abecker et.al. [1]*

Furthermore, I will show, that this approach fulfills also the idea of *Corporate Knowledge Management* described in [5]. Dieng. et. al describe the building of a corporate memory as relying on six steps: *(1) Detection of needs in corporate memory, (2) Construction of the corporate memory, (3) Diffusion of the corprate memory, (4) Use of the corporate memory, (5) Evaluation of the corporate memory (6) Maintenance and evolution of the corporate memory.* All steps can be found in the proposed concept in a very natural and user-friendly implementation, as will be shown in the following sections.

4. The Question

The first goal to be achieved is to motivate users to use the KMS. This can be done as the system allows the users to pose questions. This is a good concept by many reasons: First of all, the users are motivated as they can use the system to solve there own problems. Secondly only topics are included into the system, that are really relevant to the persons involved in a project, a user community etc. Moreover the (project) manager can receive an idea about the open problems in his or her division or project(s) by watching the problems posted to the system. Steering activities like getting knowledge from outside may be a consequence.

More generally spoken, the question can be seen as a *cristallisation point for knowledge*. Questions show interest as well as problems; questions can also start communication, bring up new ideas and initiate projects.

5. Closing the Gap: The System

5.1. Introduction

Figure 1 shows the basic ideas of the nescience management — question driven concept as use-case diagram. In the diagram the following roles are introduced:

- Project User: This is a person in a project, company who has access to the system. This is a "normal" user.
- Administrator: This is a person who administrates the system. To keep the diagram simple, this role is not included in the diagram, as the administrative functions are not central to the functional ideas.
- Project Manager: This person manages a project or is a "normal" manager in a company or institute. This user has advanced functionalities compared to "normal" project users.
- *System:* This role is implemented as software component. Automatic administrative tasks are performed by the system.
- *Intelligent Agent:* The system should have an open design using open W3C standards like a webservice interface [15]. So software agents may be implemented to support specific KM and integrative tasks.

The next sections descibe the details of the use-cases.

5.2. Documenting Problems

If a user has a problem, he/she can pose a question to the system. This question is checked by the system whether this or a similar question is already in the knowledge repository. If the system detects possible identical or similar questions (no matter whether they have been answered already), the user is asked if those questions are similar to the one he or she asked. If not, the new question is added to the repository of open questions.

If no answer is given to the question by some other users, the system asks after a specific time if the question is still relevant or if the user eventually has solved the problem already. If so, the user is asked to write an answer to his own question. The reason is simple: this system should build up a knowledge repository, not only a question repository.

5.3. KM Portal and Evaluation/Ranking System

Every time the user visits the KM "portal" the recently posted questions are shown and the user is encouraged to answer questions if possible. Moreover a user can register him/herself to open questions to demonstrate that he/she is interested in the answer to this question, too. This increases the importance rating of the pending problem.

If the user answers a question, this answer is added to the repository and the persons registered to the question receive a notification, that the question has be answered. Then all users should read the answer and evaluate the quality of the answer. This information is very important as it helps ranking the answer in the KM system as well as it helps to give credits to the person that wrote the answer. (A credit is a (semi-)quantitative measure, that allows to rank the intensity and quality of users helping in the problem solving process. It can be used in an analogous manner as real money.)

It is important to remark at this point, that first of all the questions should help to get direct answers, but secondly can be seen as cristallisation point for ideas and concepts. As Sunassee et. al. remark:

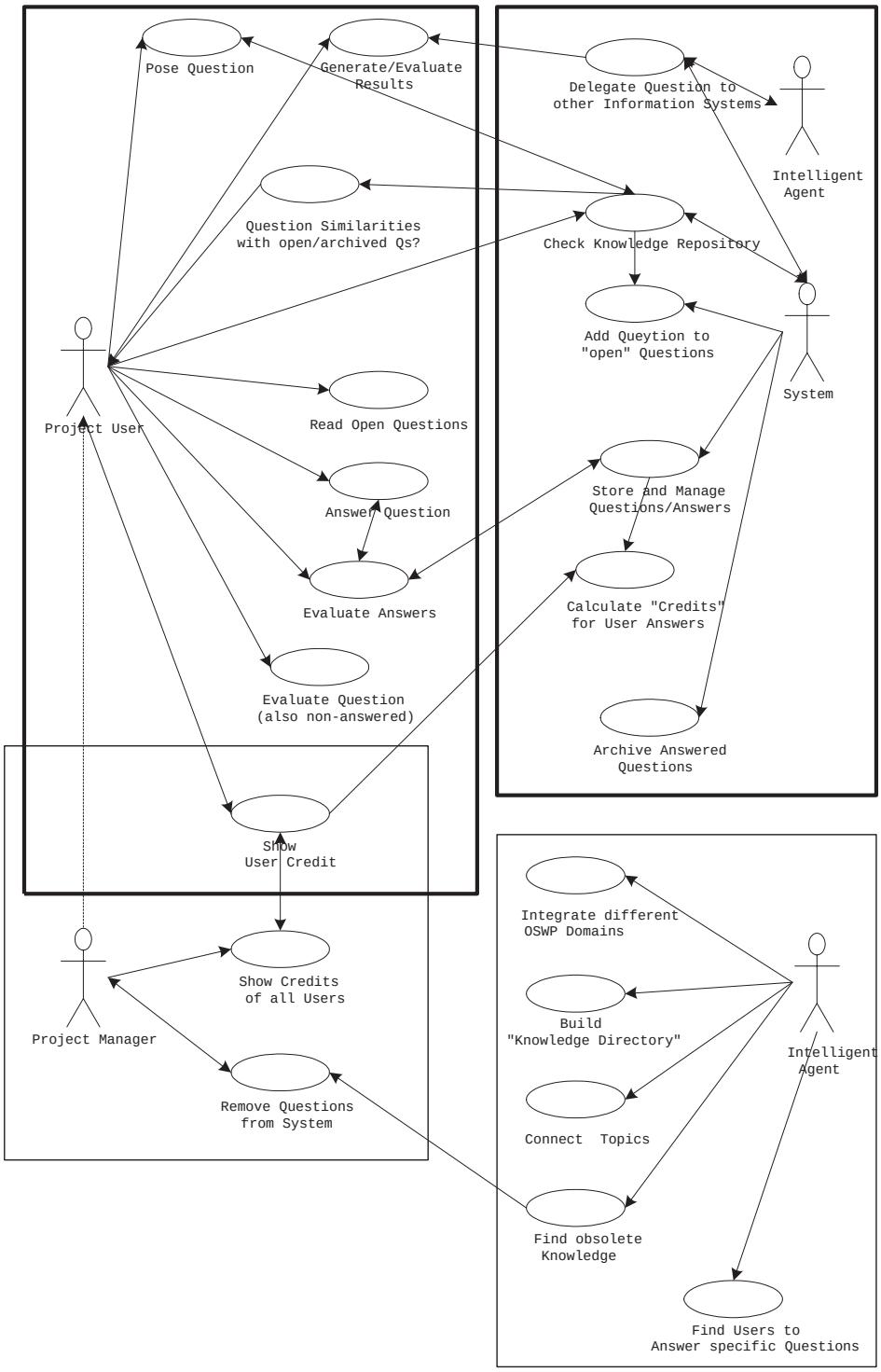

Figure 1. Use Cases for Knowledge Management Concept for the four main roles: The normal user, the project manager, the system and the agent support.

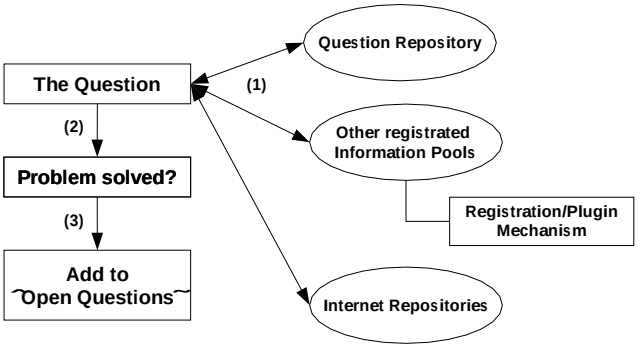

Figure 2. Integration of Knowledge Management Concepts

> "The chief knowledge officer needs to establish both *pull* and *push* factors to force employees to share knowledge. An example of a push factor would be to force employees to search through the knowledge repository before starting a project or a business venture." *Sunassee et. al. [14]*

This is guaranteed from the technical viewpoint of the system, but the users must be encouraged to see the opportunities of the system used this way. Hence it is important that the users search the repository, post question but also rank unanswered questions and eventually discuss about answered as well as unanswered questions. This gives managers the chance to detect problems and support the coworkers.

5.4. The Question as Bridge to other KM Systems

KM literature often emphasises the importance of strategies we call data mining [5, 11]. This means, that certain KM systems focus on search, retrieval and integration of different information ressources like documents, databases, ...to build an "organisational memory" using (among others) ontologies.

However, one essential point is how to integrate the "prepared information" into a knowledge repository. I believe, that this question-based system could be a well suited integrative tool. This is illustrated in Fig. 2 where the question-based approach can also be seen as smart approach in integration of KM tools/concepts: (1) Question is posed and the question repository as well as "pluggable" other information pools are queried. (2) The user is asked if the problem is solved by the results delivered and (3) Either the open question or the solved question eventually is added to the KM repository.

As soon as a question is posed by a user, the system should evaluate the question ressources as mentioned above, but also start a "broadcasting" of this problem to other registered information subsystems like the database pool, the document repository and the like. An "intelligent" analysis tool should then present the user a selection of hopefully useful ressources already available in the system. Additionally also agents could be written, that search outside the system, e.g. by using web-search enginges or newsgroup search engines. As soon as those results are collected, the user should decide whether these ressources already solve the posed problem, and if not, the question should be put to the "open question" repository.

If the problem is already solved by the ressources provided, it could be a good idea to let the user select and mark the ressources that helped him solving the problem and put this question as solved into the knowledge repository including the marked ressources.

5.5. Credit System: KM as Marketplace

This kind of KMS can be seen also as a knowledge marketplace. As users rank answers to questions, this ranking will be calculated to credit points for users who answer questions. Those credits can be seen as a money equivalent, where multiple strategies can result, depending on the company structure or the intention of the system. Just to mention a few:

- Users with high credits can be published at the KM portal.
- The credits can be exchanged to real money or other beneficiaries to encourage users to share their knowledge [8].
- Questions from users with high credits could be handled with priority (e.g. on the portal page) to encourage cooperation.
- A combination from user credits, question ranking and evaluation can be used to enhance the quality of the KMS repository.

5.6. Project Manager

The (project) manager(s) can browse the credits of the colleagues and eventually react to the credits like giving beneficiaries to high credited users. Additionally the manager can remove irrelevant or "bad" or obsolete questions from the system. Eventually he/she can help categorizing topics.

Espcially the aspect of removing (or at least marking) obsolete messages (as also written in the next section) is a

critical aspect of any KM system as Stewart et.al [13] analyze in details. Knowledge can be obsolete by many reasons: Especially in the IT domain, certain knowledge is useful only for a small period of time. Moreover new knowledge might replace older knowledge, e.g. because specific products are replaced by new ones. Hence the KM System has to support the project manager (and eventually also the user) to remove such outdated informtion.

Additionally on posing new questions the user should optionally have the opportunity to add constraints to the question. Such constraints could be: How long is the question relevant? Is the question related to a specific system or product.

5.7. System Role

The system has to perform several functions like evaluating new questions as mentioned above, managing the repository, calculate credits; eventually do archival tasks for old questions. Moreover an open interface should be implemented (Webservice) that allows to develop software agents for specific purposes like integrating different KMS domains (servers), e.g. from different locations. A "knowledge directory" to ease the access to the knowledge repository should be built with suggestions of connections between topics (this means makeing references between simila topics). A further important system role is to support the finding of obsolete topics. Other advanced functions could be building newsletters or trying to find users that could possibly answer open questions (on the basis of the usage history).

However, the interface should be generalized and open, so that it is easily possible to "plug in" new agents that cooperate in analyzing the knowledge repository. Off course each agent has to have an responsible user to report the results to. Also some problems can not be solved by the agent and final decisions have to be met be this person.

So to conclude: The system role is to support the project manager and the user as described in the previous sections and additionally support an open interface to the KM system, that allows flexible addition of functionality.

6. Other Aspects and Definitions of Knowledge Management

6.1. Different Viewpoints towards Systems

This paper is deals with "knowledge management". In fact the term KM can be seen from very different perspectives. The concept mentioned here is a rather close perspective of KM. In other publications, the KM term is used in a much broader sense, including cooperation, communication, document management, ontology aspects and also the important aspect of *knowledge preservation* [2]. So from this perspective many concepts in this paper can be seen under the light of knowledge management, also the very critical problems of preserving digital information [7, 16]. Another term used is *knowledge capitalization* and should be cited here, as it describes an important topic. It starts with:

> "[...] to reuse, in a relevant way, the knowledge of a given domain previously stored and modeled, in order to perform new tasks." *Abecker et.al. [2]*

and continues with

> "[...] an Organisational Memory[2] should also support knowledge creation and organizational learning." *Abecker et.al. [2]*

Espically the second one is a clear example of what our idea of KM is, and what the concept described in this paper should fulfill. (In fact the system suggested here goes beyond this function, but knowledge creation and organisational learning are key functions). Moreover there is the aspect of information reuse e.g.:

> "Case based reasoning allows to reason from experiences and cases already encountered, in order to solve new problems." *Dieng et.al. [5]*

Information reuse and more important: keeping the access to older information ressources available is a daunting but very important task. I believe, that there is much to learn from previous projects, especially also in the university context, where the "corporate memory" is not so highly expressed as the personal fluctuation is very high by principle.

However, as nearly all CSCW efforts can be seen as KM, thus I see two uses of the word KM: first of all concrete actions taken to acquire and manage knowledge of persons in organisations, this is mentioned here, and secondly like an idea flowing parallel to all CSCW ideas. I like to keep them separate as the second use can be seen so generally that it might be set on top of every system, so suddenly every IT system might become a KM system. It might be doubtful, if this is a desired goal.

6.2. The Next Step: AI, Expert Systems...?

One might argue that the next step (or following my description above — also seen as the next viewpoint) of information and KM systems might be expert systems or more

[2] This is a term introduced by Abecker et.al. and describes a specific KM scenario

generally the implementation of AI "artificial intelligence" to such an information system, whatever exact meaning the AI term might have. I think the perspective is correct, that structured knowledge and data bases like the described might offer an interesting playground for "intelligent tools" that try to extract new knowledge or new relations not realized before. If those tools are named AI tools or data mining tools or whatever else is of no great importance. However these fields of expertise are already too far away from the core topic, so I will not add specific ideas about those possibilities in this work except two remarks:

The first remark is a technical one concluded by an important insight: As I described the KM system above, open standards in general are important, and more specific an open interface (e.g. using webservices) is suggested including the idea, that "intelligent agents" could plug in there and perform whatever desired. This mechanism can be exploited by any tool. The insight might be, that the suggested project information and KM system can be seen on the next level of abstraction as a ressource system for high level tools like databases are today. Eventually we will use such systems in 5 to 10 years comparable to the ubiquitous use of databases today, which are seen more and more as cheap basic infrastructure available everywhere.

The second remark considering AI is to ask a question about the goal of such a system:

> "It is time to recognize that the original goals of AI were not merely extremely difficult, they were goals that, although glamorous and motivating, sent the discipline off in the wrong direction. If indeed our objective is to build computer systems that solve very challenging problems, my thesis is that
>
> $$IA > AI$$
>
> that is, that intelligence amplifying systems can, at any given level of available systems technology, beat AI systems. That is, a machine and a mind can beat a mind-imitating machine working by itself." *Frederick P. Brooks, Jr. [4]*

I believe, that this is a pragmatic but a very sympatic theory. It summarizes the intention of this paper, namely to build complex IT infrastructure that supports groups of collaborators to manage and organize project knowledge and ressources by providing universal access. Universal access in terms of a highly integrated workspace, access from anywhere and access for non-expert users. Hence this system can be seen as described by F.P. Brooks as an intelligence amplifying system for project collaboration.

7. Risks of Introducing KM Systems into Practical Use

As Stewart et.al.[13] note, there are assumptions underlying the management of knowledge, that are not often discussed, but may be critical in deciding whether KM strategies are useful and might support project work. He describes and analyzes four basic assumptions: "(1) knowledge is worth managing (2) organizations benefit from managing knowledge (3) knowledge can be managed (4) and little risk is associated with managing knowledge."

To go into details: Following the arguments in the introduction, it seems to be clear, that it is assumed here, that the questions whether knowledge is worth managing and if organisations benefit from managin knowledge is true in many cases. Off course there is to remark, that there are situations where the installation of a KM system seems no to be appropriate. Just to mention a few: KM approaches like the one suggested here need a "critical mass", a minimum number of users in the KM "community". Moreover there are surely enterprises where knowledge is not a system critical factor.

The issue if knowledge *can* be managed is difficult to answer. As mentioned and analized in [13, 3] "the management of knowledge is substantially more difficult than managing physical assets." To answer this question, many authors suggest to differentiate between two kinds of knowledge:

> "There are two types of knowledge: tacit knowledge and explicit knowledge [...] Tacit knowledge is the form of knowledge that is subconsciously understood and applied, difficult to articulate, developed from direct experience and action and usually shared through highly interactive conversation, storytelling and shared experience. Explicit knowledge, on the other hand, is easy to articulate, capture and distribute in different formats, since it is formal and systematic." *Sunassee et.al. [14]*

So the question is splitted into two questions: the management of explicit knowledge seems to be mainly a question of successful implementation of an information and ressource management strategy. More difficult is the management of tacit knowledge. So the KM as suggested in this paper is mainly designed to deal with the practical problems of managing the latter kind of knowledge.

Besides technical issues many "psychological pitfalls" exist. The most critical is the question of user acceptance: This is already a problem described related to the CSCW implemenation, as there is always a momentum away from new systems. So a new system has to be propagated in two ways: First of all there should be a clear advantage to each

user compared to the old system and secondly there must be a clear position of the management to use this systems[3]. Already problematic for CSCW systems, these arguments are even more critical in KM system implementations, as the user might be afraid, that his or her knowledge should be included into the KM system, and then his or her value in the firm becomes less important. Then some might tend toward using a strategy to try everything to work against the new system and as this will be the employees with the best knowledge (as their risk of loosing weight is the highest), the implementation of the system will clearly fail.

Therefor each employee must have the feeling, that the KM system is useful for him or herself (directly) and a "bottom up strategy" is suggested. The implementation must be done carefully — also because the KM system will not be able to replace good employees — the opposite is true: A KM system is a vivid system and needs continuos input as well as evaluation of the content. The system will stay as good as the users are that work with the content, This fact must be explained clearly to all employees.

A second psychological factor is the problem of possible information overload. This is a concern of many managers as it is analyzed in [3]. The design of a CSCW and/or KM system might not be simply to install *yet another desktop/web application*. As already discussed at various locations in this paper, CSCW and KM are somewhat "holistic" approaches and have to be seen as such. The user should be included and well trained, as well as the particular situation of the company and the role of the user must be taken into consideration. But most important is to build a unified access "portal" to all groupware applications. The user must be able to get a clear and clean (not overloaded) overview over the currently available new and important information by starting one application or open one intranet portal. Otherwise the user will either be confused, overloaded or will not use one of the systems.

A last risk factor should not be forgotten: Information or knowledge, that is stored in computer systems can be stolen, abused or might get lost by technical problems. Especially the first issue is complex one and may seriously damage a knowledge-based company. No simple strategy can be suggested here, except that this factor is very important and the implementation and installation of any KM system has to take those security problems seriously into consideration.

8. Evaluation of the System

The evaluation of such a new system is an essential point to detect whether the implementation (in a specific domain) is successful or not. As this system is a reactive rather than a proactive one, the evaluation is far easier: First of all the frequency of use can be detected (also by user groups down to individual users): As users pose problems and questions, the frequency of answers as well as the quality of answers can easily by documented and evaluated as this is already part of the system and needs no additional steps.

This transparency of the system is one of the main advantages: for daily use of the individual, for the management as well as for the evaluation purpose. Knowledge is added when necessary and evaluated automatically.

[3]This includes, that the management itself uses the system. It is not acceptable, that e.g. the management implements a new CSCW system and does not use it by themselves!

9. Summary and Further Work

Knowledge management is more and more a critical factor in success or failure of knowledge based companies and institutions. However, many different concepts and pitfalls are existing in this area of research, as well as somtimes a confusing terminology is used. We suggested a new concept that accepts the fact that growing knowledge always produces nescience and the management of the nescience is the factor of future success. The proposed system closes the gap from nescience to knowledge management and managment decision support and integrates well into (existing) CSCW and communication applications/infrastructure.

To prove the integrative power of the suggested concept, a prototype is currently under implementation into the new release of the open source project management and cooperation system Open Science Workplace, which is a cooperative effort between the Institute for Software Technology and Interactive Systems (Vienna University of Technology) and the University of Kerman [9].

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