Working Paper

Knowledge Management Systems Design

By

Volker Mahnke and
Markus Verzin

No. 17-2004

Institut for Informatik

Handelshøjskolen
i København

Howitzvej 60
2000 Frederiksberg

Tlf.: 3815 2400
Fax: 3815 2401
http://www.inf.cbs.dk

Department of Informatics

Copenhagen
Business School

Howitzvej 60
DK-2000 Frederiksberg
Denmark

Tel.: +45 3815 2400
Fax: +45 3815 2401
http://www.inf.cbs.dk

Knowledge Management Systems Design

Volker Mahnke[1] and Markus Verzin[2]

[1)] Copenhagen Business School, Denmark
[2)] Bocconi University, Italy

After a decade of articles and projects around the management of knowledge, we see a high degree of dissatisfaction with knowledge management as a managerial tool in the Multi-National Corporations (MNC). It is increasingly evident that knowledge management systems designed on an ad hoc basis do often not survive beyond initial fascination. This paper outlines several practical choices that managers need to address when designing knowledge management systems.

1 Knowledge Management: From Hype to Disgrace?

In the following, we argue that choices made in knowledge management system design with regards to (a) centralisation, (b) incentives, (c) information and communication technology (ICT) support, and (d) knowledge codification need to be strategically aligned to be complementary to each other. Successful implementation of knowledge management projects is based on system design decisions that are not disconnected, but are internally consistent and strategically aligned. We are going to illustrate how system design decisions may improve the quality of knowledge management activities using the case of the HeidelbergCement (HC) knowledge management initiative. In particular, we discuss how practices can be aligned to yield complementarities, i.e. system effects where the value of applying one practice is enhanced by simultaneously applying another (Milgrom & Roberts 1992). We illustrate our arguments with evidence from HC. Conclusions for managers in charge of designing knowledge management systems follow.

After its first appearances in the late 1980s and early 1990s, "knowledge management" developed into a major subject of crucial concern to the management of the modern MNC (Bartlett & Ghoshal 1989; Mahnke & Pedersen 2004). Decisive part in the proliferation of knowledge management had the writings of Alvin Toffler (1990) on the "knowledge society", Nonaka & Takeuchi (1995) and von Krogh et al (2000) on knowledge creation in companies, as well as Grant & Baden-Fuller (1995) and Grant (1996) on knowledge integration. The main message was: Knowledge has taken precedence over traditional organisational resources such as labour, capital and land. Consequently, business writers and several progressive MNCs began to

think about how crucial knowledge can be captured, shared, and exploited to achieve competitive advantage.

Many managers attempting to implement knowledge management systems seem to be disappointed with the effectiveness of knowledge management as a managerial instrument to achieve competitive advantage. In a recent study by Rigby (2001), more than 214 executives from different North American and European companies evaluated the effectiveness of 25 top management tools. On a scale from 1 (highly dissatisfied) to 5 (highly satisfied), knowledge management ranks 25$^{th.}$. Clearly, knowledge management today is less favourably regarded compared to the past euphoria. Has it fallen in disgrace in the eyes of top management? Several reasons might explain this, including the following.

Some companies have invested heavily in information and communication technology to support knowledge management initiatives, but people involved in business operations have made little use of this technology. Other companies were betting on grassroots initiatives in the belief that knowledge management only works when people involved in business operations engage in communities of practice that work largely untouched by managerial intervention, only to be later disappointed that the initiative had little to do with the strategic concerns of the company. Some companies provide incentives to store knowledge on electronic knowledge sharing systems, only to see some employees upload irrelevant knowledge and others burn precious time searching large amounts of data. Some companies have made knowledge creation and sharing a special responsibility of centres of excellence, but then central experts left the centres to pursue innovative ideas on their own. Unfortunately, many knowledge management systems are ill-headed and suffer from flawed design.

The list of system elements (e.g. communities of practice, corporate university, centres of excellence, knowledge portals) in knowledge management practices has reached a substantial dimension and there is nothing inherently wrong with such lists of recommended tools and general advice. The problem is, however, that such lists are not particularly helpful when system elements are not aligned with the organisation and a company's strategy through sound knowledge management system design. The challenge for companies is to understand how to select and align system elements in a complementary way by considering a set of system design choices.

2 Implementing knowledge management in HeidelbergCement

With around 1,500 locations in more than 50 countries, 38,000 employees, and worldwide cement and concrete sales amounting to more than 6 billion Euro, HC is one of the four largest cement manufacturers in the world. Back in 1998, HC did not have an explicit knowledge management system. Today, the company has a variety of new practices that link knowledge management to the pre-existing organisation. HC managed to use the results of a relatively short knowledge management project and made the organisation absorb and further develop the initial ideas of the project team. The project was structured along 5 phases. The below described processes have been used within HC for similar projects.

Phase 1: Create awareness for global knowledge sharing

In 1998, some executives started to think about knowledge management after reading articles in the business press and participating in some management seminars. The "Vorstand" (Executive Board of Directors) first came up with the idea of improving knowledge flows between distinct plants in 1999. Its members

felt that in different parts of the world, plants spent a considerable amount of time and money on developing solutions that already existed in other parts of the company.

Mainly due to the fast growth of HC by acquisitions, knowledge had to overcome geographical barriers as well as differences in national and company cultures. The challenge HC was facing was to create new knowledge involving the global network of companies and to make sure that everyone had access to the global knowledge base. This knowledge existed in many different places such as databases, reports, and books, but also in peoples' heads. Skills and experiences are or should be distributed right across the whole company. But all too often, especially for intensively geographically diverted companies like HC, one part of the company repeats the work of another simply because it is difficult to keep track, and make use, of knowledge in other parts or plants.

In a first workshop in January 2000, the top-management team of Heidelberg Technology Center (HTC) started studying the issue of how to accelerate international knowledge sharing. HTC is the technical think-tank of HC with around 170 engineers. The HTC managing directors took the lead in setting up a proposal for a knowledge management project. The main objectives of the project were (1) to identify relevant knowledge areas, (2) to get a clear understanding of available knowledge within the group, (3) to create organisational processes that ensure effective knowledge sharing across national and functional boundaries, and (4) to exploit existing knowledge on a global scale. In view of the increased complexity of such a project due to the current rapid growth phase through acquisitions and the decentralised decision making processes, HTC decided to use a small consulting company to support the project.

Phase 2: Seeking institutional support and legitimation

As a next step, the project proposal was presented to the Board of Directors of HC which approved it with 2 limitations: it should focus on technological aspects of the cement business only, and it should be an integrated part of the company-wide "corporate mission project". By focusing on the technical area, the reduced complexity of the project made it possible to implement proposals more effectively without engaging in long negotiation processes throughout the company. Linking the knowledge management project to the corporate mission project was also beneficial. The main objective of the corporate mission project was to bridge different cultures and give the company a new identity, which would include the increased variety of new companies and regions. The discussion of global values and the resulting sensitivity to "soft" issues prepared the grounds for the knowledge management project "Einstein". The board expected from "Einstein" a significant contribution to increase communication within HC.

Phase 3: From kick-off to strategic alignment

The project kick-off was planned to take place at a management meeting in September 2000 that would gather 150 senior managers from all over the world. A 6-page brochure was developed describing what knowledge management is and what the scope of the project was. For those employees who were interested, an information corner was set up to discuss with project managers. In addition, a project intranet site was set up to ensure timely updates of the project progress. The knowledge management project ran for 10 months and involved the headquarter level, 6 geographical divisions, 3 suppliers, and one industry association of this large MNC located in Germany.

In the first phase of the project, 15 unstructured interviews were carried out that allowed the research team to get a general understanding of the industry and the functioning of the company itself. Based on these, 51 semi-structured field interviews of 60 to 120 minutes were conducted focusing on different geographical regions (Germany, Czech Republic, Sweden, Africa, Asia, Turkey, Belgium and the US). The interview partners were all part of the top 400 executives. Informants (around 100 in total) included the CEOs responsible for each group under which there was a studied division, each general manager (one per division), functional managers (multiple managers for each division), and project managers. Informants were briefed beforehand regarding the scope of the research, and the interview notes were written within 24 hours of the interview. Interviews typically lasted 90 minutes, although some went on for several hours. The interview data was supplemented with other data relating to the company, its strategy and its business environment drawn from participants' observations, published articles, and internal company documents.

The results of these interviews allowed the project team to identify what was called "knowledge management opportunities". 6 workshops around these key topics of at least one day of length were defined and carried out. Each workshop was composed of an average of around 12 participants coming from the entire company. Previously interviewed employees were complemented with experts in the fields of interest. Based on the workshop results and on the previous interviews, the HC Knowledge Management System was developed.

Phase 4: From strategic alignment to organisation architecture

The project results were presented and the board of directors approved all suggestions made by the project team. A 2-year plan was developed to ensure

that implementation was timely and effective. Project Einstein was at that time officially finished and the implementation tasks were delegated to several line functions. The tasks of the steering committee of the project team were taken over by the "Knowledge Management Board" (KMB).

The integrated HC knowledge management Model has 3 main components: (a) The WOC portal, (b) the four promoters for knowledge sharing, and (c) the knowledge navigator. The WOC portal builds the foundations for effective knowledge exchange because it makes explicit knowledge easily accessible for everyone in the company worldwide. Past experiences have, however, shown that a knowledge portal as an island solution is not a big enough contribution to facilitating knowledge transfer. Information and Documentation Services as administration functions ensure, in cooperation with Regional Coordinators (RCOs) and Expert Group Leaders, the strategic and operational flow of technical information within HC.

In addition to data storage and retrieval systems, the human side of knowledge sharing needs to be supported. The promoters that drive this aspect of knowledge sharing are the communities of practice, the expert groups, the RCOs and the corporate university. The knowledge navigator as a third building block attempts both to coordinate knowledge management activities and measure the effect of knowledge and knowledge management on the company performance. It also governs the knowledge promoters accordingly.

<Insert Figure 1>

Phase 5: Measurement of success

In this phase, the continuous measurement of the effects of the knowledge management system on individual and organisational performance was measured. A reason for the low degree of satisfaction with knowledge management projects is that "success" is hard to categorise and measure. As with most projects that aim at changing behavioural aspects of a company, it is difficult to prove their immediate impact on the bottom line. As a consequence, one has to develop a set of clear project goals and indicators for their achievement. If these indicators are observed over time, they may provide a meter for change. Hence, the KMB was looking for indicators that would justify the investment in knowledge management

One example of such indicators comes from the maintenance activities of the company: A goal at the beginning of the project was to reduce, ceteris paribus (especially regarding repair costs), the global maintenance costs. By creating a global database for maintenance projects, existing solutions could be re-applied for similar maintenance issues. The project guidelines were adapted to ensure that local maintenance experts made use of that knowledge pool. Before starting to develop their own solution, these experts have to sign a module attesting that no existing solutions could be found. As a last step, the project procedure now finishes with the preparation of modules for potential re-use. As one might recognise, knowledge management has a potential impact on the maintenance costs of the company. Although the reduction in these maintenance costs cannot be attributed alone to changes in the way HC manages its knowledge, it still indicates the success of the knowledge management system. Similarly, the RCO's yearly job evaluation now includes measures for knowledge sharing attitude and behaviour, which triggers a discussion and evaluation of what it means to deal professionally with knowledge.

Besides those performance indicators on the micro-level, the KMB analyses the degree of satisfaction with the knowledge management tools with a survey for the first 2 years and then every 3 years. The survey attempts to gather data on how the knowledge initiative affects organisational behaviour, which in turn has an impact on the performance of the organisation. The first survey included 265 employees and had a return rate of 83%. The high response rate as well as the high mean in most questions indicates a high interest in Project Einstein and in knowledge management in general, good project communication, high expectations and high trust in the project. However, the results of the survey will have more significant explanatory power once the survey is repeated and dynamic data are available.

Other indicators that measure the success of the knowledge management initiative may come from each single knowledge management instrument. The performance of the expert groups is evaluated based on the hit rates of their intranet sites. The corporate university triggers high interest worldwide, considering that over 400 employees out of a target group of 800 employees participated in the first year and requested a brochure, either in electronic or paper format. The technical innovation contest received similarly high attention: a call to participate in a business plan contest triggered 106 different ideas.

3 Knowledge Management System Design: Essential Choices

As one may deduce from the case description, designing knowledge management systems requires the analysis of several essential choices that characterise a company's knowledge management system. The first choice concerns the question whether knowledge should be shared in a codified form and/or through personal interaction. The second one deals with the question

whether knowledge creation and sharing should be centralised to become the responsibility of few or de-centralised to become the responsibility of many. The third essential choice concerns the question when and to which degree knowledge sharing should be rewarded. The final choice concerns the question to which degree ICT should be used to foster and accelerate knowledge sharing. All four essential choices are interrelated so that a key managerial challenge is to align them strategically to reach complementarities.

Codification vs. Personalisation Strategy

There are two very different knowledge management strategies companies may employ, depending on their overall competitive strategy (Hansen, 1999). Applying a people-to-document approach, a company attempts to extract knowledge from the person who developed it, make it independent from that person, and store it in databases, where it can be accessed and used by others in the company. This approach is called the codification strategy. Following this type of strategy opens the possibility of achieving scale and scope in knowledge re-use. Examples of companies using this strategy are among others Ernst & Young and Deloitte & Touche --- companies that provide services with standardised components and processes that can be re-used on a number of occasions. In other companies, where services and products depend more on individual expertise that cannot be easily standardised, direct person-to-person contacts seem more appropriate to develop and share knowledge. Companies applying this strategy are among others Boston Consulting Group and McKinsey; companies that provide solutions to unique customer problems. Which knowledge management strategy to choose depends among other things on a company's competitive strategy and product market positioning. If a company provides standardised solutions with high degrees of reliability, a

codification strategy is the obvious choice. But if it offers client solutions that are rich in tacit knowledge and offerings are highly customised and innovative, a personalisation strategy seems more appropriate. While companies need to make choices on their primary strategy to the design of knowledge management systems, companies offering unique solutions will also have processes and routines that are stable and occur frequently. If this is the case, companies need to distinguish between codification and personalisation strategies to the design of knowledge management systems based on a thorough analysis of knowledge types involved in a particular activity.

Lest knowledge involved in a particular activity is completely tacit, companies have the choice to invest in externalisation, detaching knowledge from knowers involved in activities, and codification to quickly share and leverage available knowledge across time and place as well as use and users. When knowledge is codified, it cannot only be easier shared and replicated to support geographic or product line expansion, but additionally it may help establish understanding needed for process improvement (Teece 1998). Alternatively, companies may leave possibilities of codification unused to operate with higher degrees of tacit knowledge (e.g. Boisot 1998). Knowledge sharing is still possible in this case, but it is limited in that it relies on costly and slow methods of sharing, such as personal transfer or apprenticeship (Nonaka & Takeuchi 1995). Additionally, when high levels of tacit knowledge are coupled with causal ambiguity, process improvements may be confined to unsystematic trial and error learning (Teece 1998). By implication, while personalisation strategies incur less fixed costs of codification, they also exhibit higher variable cost each time knowledge is shared. Codification of knowledge should thus be seen as an investment, the costs of which are determined by the prevalent knowledge type (e.g. tacit vs. explicit) present in a particular activity. Thus, codification investments need also

justification by future savings realised through economies of scale and scope of knowledge re-use as well as reduced variable costs of knowledge sharing.

At the beginning of the knowledge management project Einstein, the knowledge strategy applied at HC reflected a person-to-person approach. Knowledge was strongly personalised and context sensitive. If codification of knowledge took place, the documents were decentrally stored in paper format, filling some binders somewhere in the organisation. The storing methodology (even on an individual level) was not structured in a globally standardised way so it was hard to find valuable knowledge. To detect knowledge, one would have to know the person who knew where to get it. As a consequence, knowledge sharing was difficult and often limited to regional (most often national) boundaries within the reach of one's own social network of experts. The WOC intranet portal was developed as a remedy against the strong focus on the tacit and context-dependent side of knowledge. Estimating the costs of externalising knowledge, the project team focused its codification efforts on strategically important knowledge with low local adaptation costs. By monitoring the hit rate of the posted documents on the intranet site, HC tries to focus its codification efforts on knowledge areas that trigger the interest of a vast group of colleagues. The WOC portal is designed to support the structuring of codified knowledge in selected areas as well as the identification of experts that may be a source of tacit knowledge. HC hence did not attempt to move its knowledge strategy towards a strong person-to-document approach, but added just a bit more features to its person-to-person approach.

Centralised vs. De-centralised Knowledge Creation

This dimension examines which individuals in a company possess decision rights both with regards to creating and sharing knowledge. According to

Sarvary (1999), there are two markedly different approaches that can be observed in this industry; the bottom-up, also called decentralised, or top-down, also called centralised, knowledge management system.

Decentralised knowledge management systems emerged from the initiative of the company's employees, with management involved only in loose coordination of the process. Solutions and problems tend to be unique to the context of its creation and as a result are difficult to codify in standard formats that can be used elsewhere in the company. As a consequence, lessons from the company's experience are hard to categorise, thus possibilities for management intervention seem to be limited, e.g. management cannot prescribe to employees what topics they should concentrate on. Instead individuals decide on their own initiative to invest their time in codifying knowledge and making it available through their personal networks and internal markets. The clear advantage of this type of knowledge management system is that it is rooted in individuals' initiative and requires little administrative overhead expenditures. As users themselves create knowledge, individually or in communities of practice (Wenger & Snyder 2000), few agency costs are incurred on behalf of the organisation, to align interest through incentives and monitoring. On the other hand, knowledge production costs may be high due to increased redundancies.

More centralised knowledge management systems are built and managed from the top. They typically organise knowledge creation through a large central department, e.g. what has been labelled centres of excellence, whose job consists of creating, synthesising and distributing the company's knowledge (Sarvary 1999). The main advantage of central system design is that it provides the opportunity for visionary breakthroughs, management can focus employees to certain strategically important areas or topics, and due to higher control and monitoring the knowledge management system is more likely to be well

organised. However, the disadvantages are that central systems require higher overhead expenditures because they are closely monitored and managed. In addition, knowledge transfer costs are high due to the geographical separation of knowledge creation and knowledge use.

Additional insights can be derived from the centre of excellence literature (Holm & Pedersen 2000). Central organisation of knowledge creation has been applied in many corporations, including companies like AT&T, IBM and Microsoft. The key advantage of this approach is that long-term, explorative and risky attempts at knowledge creation are protected from the pressures of daily operations and budget constraints. However, the remoteness to current business may make knowledge creation unresponsive to market demands, leads to slower knowledge commercialisation, and also poses the threat of inbreeding in self-contained think tanks following more their intellectual curiosity rather than furthering the company's aspirations. On the other hand, dispersed knowledge creation may lead to double invention, locally contained solutions and thinking in functional silos.

Because both approaches to knowledge system design have advantages and disadvantages, choosing between them poses the question of what the system should achieve. March (1991) differentiates between two learning processes within organisations that knowledge system design may achieve, namely *exploitation* and *exploration*. The essence of exploitation is the refinement and extension of existing knowledge. It is an incremental learning process and its returns are highly predictable. On the other hand, exploration centres on the experimentation with new alternatives and its returns are therefore according to March (1991) uncertain, distant and, at times, negative. The focus here is on developing innovation and creative breakthrough that deviate substantially from what organisations know and do currently. Due to the degree of uncertainty

involved, there is a tendency to overemphasise exploitation of known alternatives and downplay the exploration of unknown territories, but to adapt successfully over time, exploitation and exploration need to be balanced. In sum therefore, the question of decentralised vs. centralised knowledge system design depends on the question of what the system is supposed to achieve. When cost intensive exploration with global exploitation of standardised knowledge is attempted, the company may tend to design knowledge management systems centrally.

HC approached the centralisation issue by creating a KMB (principal) at headquarter level, which has the task of monitoring and guiding knowledge groups (agents), such as the expert groups. The KMB is composed of highly ranking line managers that serve as members of the board as a part time job. In fact, the board meets only twice a year. The Technical Marketing Committee and the Environmental Committee are supporting the KMB. The missions of both additional Committees are the following:

- Definition and assessment of synergies in the area of environmental protection within HC, covering all strategic business units, and subsequent proposal of actions
- Assessment of technical innovations in the area of environmental protection/technical marketing and proposal of actions
- Ensuring transfer of know-how between SBUs
- Definition, prioritisation and coordination of group-wide studies and R&D projects
- Development of policies and standards in the field of environmental protection
- Preparation and formulation of consistent HC positions in associations and other committees

- Development of policies and standards in the areas quality, products and R&D
- Preparation and formulation of consistent HC positions in associations and standardisation bodies, and proposal of members
- Proposals for HC representatives in international environmental protection committees
- Proposals for Communities of Practice/Expert Groups in the field of environmental protection and suggestion of experts and Practice Leaders

The KMB allocates decision rights to the knowledge groups and assigns distinct roles and responsibilities for selected members within those groups. During the design phase of the relationship between the knowledge groups and the KMB, the project team studied existing literature on Communities of Practice and was surprised by the informal and autonomous nature of those groups. It has been argued in academic articles that knowledge-based competition requires employee autonomy to unlock high involvement in self-managed teams (Cohen, Ledford & Spreitzer 1996). Communities of practice "… are groups of people internally bound together by shared expertise and passion for a joint enterprise … its primary output is knowledge" (Wenger & Snyder 2000, pp. 139-140). For communities of practice to function, managers "… must legitimize and support the myriad enacting activities perpetrated by its different members. This support cannot be intrusive, and knowledge teams…must be allowed some latitude to shake themselves free of received wisdom". (Brown & Duguid 1991, pp. 53).

The immediate reaction of the project head was that he did not intend to spend time and money on the identification of strategically relevant knowledge areas just to wait and see if communities of practice were autonomously emerging and taking care of these issues. This seemed to be more likely to happen in smaller organisations where everybody knows everybody. "How long do you want to

wait until an expert from Brunai calls up his German colleague?" Another risk the project manager feared was that those communities of practice would end up as "discussion clubs" without any pressure to produce results. Consequently, the KMB nominated for each strategic knowledge area an expert group with an expert leader. The communities of practice would autonomously form themselves around the expert groups and support them with ideas and feedback. As indicated in figure 10.2, different decision rights were given to each group by the KMB.

<Insert Figure 2>

Based on the discussions with the knowledge teams at HC, and those responsible for delegating decision rights to them, two contingency factors emerged in the process: (1) knowledge process (whether the main focus of the team was on knowledge exploration or on knowledge exploitation); and (2) strategic impact of knowledge (whether the team focused on strategically important knowledge). In the opinions of the project team, both influence the degree of autonomy of the knowledge management teams as well as the decision rights granted to it as independent variables. Strategic importance is perceived as the potential impact of knowledge teams on cost and differentiation drivers related to particular industry trends and value chain activities (see figure 10.2). As one KMB member put it: "We want to have control on attempts to knowledge sharing and creation whenever the team work has an immediate and/or important impact on our strategic orientation."

Incentives for knowledge sharing

As suggested by much research on knowledge management (see Argote 1999; von Krogh et al 2000 for a synthesis), knowledge management systems need to

provide access to other MNC unit's knowledge. Only when MNC employees can identify valuable knowledge by searching topics or knowledgeable partners in other MNC units without incurring substantial transaction costs (Mahnke & Venzin 2003) will they be able and motivated to utilise knowledge inflows. By contrast, when individual transaction costs of knowledge search and access are substantial, for example because adequate communication channels are missing, individual's motivation will decrease accordingly.

Opinions on the influence of providing incentives (both formal and informal) for knowledge sharing to increase the motivation of for example a MNC subsidiary's employees remain divided. On the one hand, several authors argue that motivation for exchanging knowledge between subsidiaries cannot be easily influenced through explicit rewards (Osterloh & Frey 2000; von Krogh et al 2000; Wenger & Snyder 2000; Bartlett & Ghoshal 1989; Ouchi 1982). First, for explicit rewards to be effective, motivators require a sound measurement base (Ouchi 1982). However, where input, output, or processes cannot be standardised and by implication easily measured, explicit incentives rewarding knowledge sharing behaviour of subsidiary employees easily become arbitrary. This may be the case where knowledge-sharing processes are surrounded by substantial causal ambiguity and uncertainty (Simonin 1999). If so, providing explicit rewards on an arbitrary measurement base can lead to the perception of unfair incentives to crowd out intrinsic motivation of subsidiary employees (Osterloh & Frey 2000).

In addition, when knowledge sharing behaviour is multidimensional in that it requires initiatives along several dimensions including active requests, networking, and building close social ties (Hansen 1999), explicit rewards that focus on one dimension to the neglect of another may undermine motivation to engage in complementary activities (Holmström & Milgrom 1991). By

implication, knowledge sharing may rather strive if participants in horizontal knowledge flows between subsidiaries are intrinsically motivated by common goals (e.g. Ouchi 1982; Osterloh and Frey 2000). Thus, signalling (Spence 1972) organisational support through informal acknowledgement may help intrinsic motivation without incurring the negative effects of misdirected extrinsic rewards.

On the other hand, employees take part in knowledge sharing only as long as the benefits exceed the costs; otherwise, they may withdraw. Accordingly, whenever possible, increasing the employees' benefits through providing explicit rewards is appropriate. For example, when subsidiary employees' knowledge sharing behaviour can be specified in less uncertain and ambiguous knowledge exchange relation, providing explicit rewards alongside informal acknowledgements can increase motivation, in particular, if explicit rewards act as a complement rather than as a substitute to intrinsic motivation (Osterloh and Frey 2000; Foss & Mahnke 2003; Laursen & Mahnke 2001). In addition, as shown by Mahnke and Venzin (2003), developing a measurement base for explicit rewards through monitoring by experts can also be seen as an investment to increase common shared knowledge between subsidiary employees, which in turn increases the ability to share knowledge among them.

Incentives work on several levels of importance to knowledge system design, including the individual, teams, and organisational unit level. At HC, a key issue was to make the knowledge/performance link visible by identifying strategically relevant knowledge areas. For example, alternative fuels have been identified as a strategically relevant knowledge area, and results of learning efforts have been made available in the form of best practice reports revealing experts involved and giving them exposure and visibility. As one project member put it: "When you can expect to assume an expert status, and the learning you generate are seen

by many, you better make sure that you produce substantial knowledge and communicate it well to those who make or break your expert status." HC also deploys several knowledge teams to foster knowledge sharing. The team for maintenance practice, for instance, aims at reducing the global maintenance costs while keeping the repair costs stable. Maintenance costs represent a major cost driver in the cement production process. A considerable potential for optimisation of the global maintenance practice exists since similar problems occur throughout many plants of HC. An isolated plant that attempts to solve maintenance issues on its own, only relying on local equipment suppliers, cannot reap the potential of inter-subsidiary knowledge sharing. Knowledge teams serve several functions to facilitate the knowledge flows across plant borders at HC, including codifying knowledge by developing reports, posting them on the WOC Portal, and communicating them across subsidiaries. Knowledge teams are expected to attract a number of subsidiary colleagues to access, refine, and integrate their knowledge, while knowledge teams failing to attract a minimum hit rate level of their posted reports are eventually dissolved.

Another knowledge team has evolved around expertise for alternative fuel technology. Similar to the previous example, the expert team was created around knowledge, which has a high impact on the profitability of the company: Energy is one of the main cost drivers in a cement plant. Consequently, the company is constantly searching for ways to reduce energy costs. Alternative fuels like tires, solvents or sewage sludge often have negative acquisition costs, but require substantial investments for environmentally friendly burning technology. The alternative fuel expert team facilitates knowledge sharing across the HC plants by developing and sharing technical solutions for alternative fuels applications and matching that knowledge with the plant's particular needs. This matching process requires blending local knowledge with centrally available technological knowledge since environmental laws, costs for alternative fuels, transportation

costs and other factors are highly dependent on the local context, while technological solutions are often generic. As a team member stated, "Everyone wants to make an impact and contribute to the well being of human kind, thus, working on green issues is an honour anyhow, when you can do this during work, this is just great."

Information and communication technology Support

Managers need also to make a choice concerning the question to which degree ICT should be used in knowledge management system design. IT can aid individual's memory, is more reliable than the human mind in standard situations, and exhibits greater scalability in terms of content stored. IT also supports extensive networks of organisational members by connecting them electronically and hence has the potential to enhance the communication channels both horizontally and vertically. For example, building a knowledge sharing portal can extent the organisational members' network and expose the individual to new knowledge sources within the organisation. IT also increases visibility and access to knowledge sources via communication tools, group support systems and retrieval tools, thus enabling the rapid development of new knowledge. Data mining and data warehousing can identify patterns in very large databases at a much faster speed than individuals. Thus, IT tools can accelerate the pace of combining explicit knowledge to create new knowledge (Nonaka & Takeuchi 1995; Alavi & Leidner 1999).

However, enabling knowledge systems through information technology in the form of web portals, communication systems, groupware and databases etc. will not automatically result in better knowledge sharing. O'Dell & Grayson (1998) point out that IT potentially reduces costs and speeds up the process of sharing of best practices and knowledge. However, IT may also lead to a flood of information that threatens to seriously overload employees' cognitive capacity.

Accordingly, IT deployment should be considered to structure knowledge, ease the identification of experts, enable communication, and facilitate new knowledge sharing relations. In sum, while IT can support as an element the company's knowledge management system, the implementation of IT systems should not be confused with knowledge management itself (McDermott, 1999).

To select IT tools, it is necessary to analyse organisational communication lines (Alavi & Leidner 1999). The type of communication line depends on the type of knowledge being transferred (tacit vs. explicit) and the way knowledge work is organised (directive vs. interactive). Knowledge can either be easily or not easily transferable through IT depending on the tacitness of knowledge in a particular work situation. Electronic knowledge repositories, portals, and communication systems may be best employed when knowledge is explicit. Tacit knowledge, on the other hand, is context-specific and is thus not easily transferred via IT. The most effective channels for sharing of tacit knowledge therefore involve personal interactions. Nonetheless, IT enabled interaction systems (e.g. groupware, project web software, discussion forums) can support dialogue between individuals and enable team collaboration and coordination.

Furthermore, knowledge transfer may be either directional or interactive. Directive transfer often uses fixed formats such as in training sessions and online course. The typical knowledge sharing situation concerns communication from one knowledge source to many knowledge recipients. Interactive transfer includes unscheduled meetings and informal knowledge requests. Here, the typical knowledge sharing situation concerns exchange between one knowledge source and one recipient, whereby roles can change as the interaction proceeds. Alavi & Leidner (1999) argue that IT can support all four types of knowledge transfer. But planning for Information and communication technology support in knowledge management system design depends on the level and form of

knowledge codification as well as the importance of interactivity required by the situation at hand.

In sum, while IT systems supporting explicit knowledge exchange aim at sharing knowledge, systems applied in tacit knowledge situations aim at connecting people. Because IT applications are costly (e.g. hardware, software, maintenance, and training), managers need to carefully choose IT support tools after having analysed work-situation and communication type.

HC deployed an intranet-solution ("The WOC Portal"), which acts as facilitator for identifying experts and communicating strategically important knowledge domains. In addition, the KMB supported by the Technical Marketing Committee, the Environmental Committee, and the Expert Groups, which includes high level representatives of top management, technological experts, and subsidiary leaders, identifies leading practices in diverse strategically relevant knowledge areas such as maintenance management, energy efficiency, new concrete applications, and emission reduction. To develop best practice reports on valuable knowledge created in leading subsidiaries, local expert knowledge is centrally codified and documented so that other subsidiaries can improve their performance based on benchmarking and the application of new solutions.

Integrating Knowledge System Elements

Recently, scholars have begun to address more rigorously complementarity effects (Milgrom & Roberts 1992; Holmström & Milgrom 1991) among knowledge management practice on a conceptual (Baron & Kreps 1999) and empirical level (Ichniowski, Shaw & Prennushi 1997; Laursen and Mahnke, 2001). Milgrom & Roberts (1995, p. 181) define complementarities as:

"...activities are Edgeworth complements if doing more of one thing increases the returns to doing (more of) the others." The four essential choices in the design of the knowledge management system are interrelated so that a key managerial challenge is to align them to reach complementarities. It is a management task to assess the complementarity effects among their system design choices. When do system elements of knowledge management design used simultaneously and, in particular, system configurations (Ichniowski, Shaw & Prennushi 1997) increase overall system effectiveness beyond what individuals achieve in isolation?

At HC, for example, it was essential to acknowledge that codification of knowledge has not been distinct. The knowledge sharing culture was strongly based on personal contacts where experts share tacit knowledge through socialisation in face-to-face meetings or by phone contact. Codification of knowledge was often limited to personal initiatives and resulted in decentral and unstructured storing of paper documents. The knowledge management project objective was to slightly increase the degree of codification in selected areas. This first knowledge management system design choice was supported by improving the Information and communication technology support and unifying the different Information and communication technology platforms used throughout the company. The structure and design of the WOC intranet portal, however, reflects the importance of personal contacts and the sometimes highly tacit nature of key knowledge. Incentives for knowledge sharing are therefore not exclusively based on the degree and success of codification efforts, but on a qualitative interpretation of knowledge sharing efforts by linking objectives to knowledge sharing activities in the incentive system of selected experts. The degree of centralisation at HC heavily depends on the strategic importance of the knowledge area. The higher the importance of the knowledge area the more centralised are the decision rights for creating and sharing knowledge.

4 Conclusions and managerial implications

The aim of this article was to suggest a way to increase the degree of satisfaction with knowledge management system design as well as to help managers avoid frustration and costly mistakes. How can you manage what you know and implement a knowledge management system? The answers to that question given by books or by appointed "Chief Knowledge Officers" read like a list of best practices: Create a "yellow pages" directory for your company knowledge; develop knowledge maps; introduce knowledge brokers; create competence centres; feed information into knowledge databases; develop a knowledge vision; work on your conversation culture; found a virtual university; develop guidelines for documentation; reward knowledge transfer; turn new knowledge into product innovations; create an invisible asset monitor. Despite the usefulness of most knowledge management tools that support knowledge management system design, companies have difficulties in implementing effective knowledge management systems. How should managers now choose the right tools and approaches? Should they intuitively pick some of the tools and start to implement them? Or is there any coherence, system or logic behind the set of best practices integrated into the own management system? Yes, there is one!

Our recommendation is that managers seeking to implement knowledge management systems need to make design choices with regards to (a) centralisation, (b) incentives, (c) ICT support, and (d) knowledge codification that need to be strategically aligned to be complementary to each other. Managers who systematically analyse these choices gain clarity in understanding their knowledge problem. After having made them, knowledge management tools should be selected to support the complementary choices made.

In most books on knowledge-management the valuable comment that the knowledge management systems have to fit the organisation comes in one of the last chapters and is dealt with in a couple of pages. Seldom, however, are managers told how such alignment should be achieved. The real managerial challenge in this respect is to understand system design choices individually before you start introducing any knowledge management tools, just like Western managers would get to know the basic behavioural rules of the Japanese culture before entering into contract negotiations in Tokyo. This is not enough, however! The potential of knowledge management can only be realised if the knowledge management system design choices are strategically aligned and complementary to each other just like several behavioural rules integrate into a coherent set of mutually reinforcing elements that form a society's cultural system.

Literature

Alavi, M. & D.E. Leidner. 1999. Knowledge Management and Knowledge Management Systems. City: McGraw-Hill.

Argote, L. 1999. *Organizational learning: Creating, retaining and transferring knowledge*. Norwell, MA: Kluwer.

Bartlett, C. & Ghoshal, S. 1989. *Managing Across Borders*. Boston: Harvard Business School Press.

Baron, J. N & D, M. Kreps. 1999. Consistent human resource practice. *California Business Review,* Vol. 41, No. 3, pp. 30-52.

Boisot, M. 1998. *Knowledge assets: Securing competitive advantage in the information economy.* Oxford: Oxford University Press.

Brown, J.S. & P. Duguid. 1991. Organizational learning and communities-of-practice: Towards a unified view of working, learning, and innovation. *Organization Science*, Vol. 2, No. 1, pp. 40-57.

Cohen, S., G.E. Ledford Jr., & G.M. Spreitzer. 1996. A predictive model of self-managing Work Team Effectiveness. *Human Relations*, Vol. 49, No.5, pp. 643–676.

Foss, N and V. Mahnke. 2003. Knowledge management: What can organizational economics contribute? In *Handbook of organizational learning and knowledge management,* Lyles, M. and M. Esterby (eds). Blackwell Publisher.

Grant, R. and C. Baden-Fuller. 1995. A knowledge based theory of inter-firm collaboration. *Academy of Management Best Paper Proceeding*, pp. 17-21

Grant, R. 1996. Toward a knowledge-based theory of the firm, *Strategic Management Journal,* Vol. 17, Winter, pp. 109-122.

Hansen, M.T. 1999. The search transfer problem: The role of weak ties in sharing knowledge across organizational subunits. *Administrative Science Quarterly*, Vol. 44, No. 1 , pp. 82-111.

Holmström, B. & Milgrom, P. 1991. Multitask principal-agent analyses: Incentive contracts, asset ownership, and job design, *Journal of Law, Economics, and Organization,* Vol. 7, No. 2, pp. 24-52.

Holm, U. & T. Pedersen. 2000. *The Emergence and Impact of MNC Centres of Excellence*. London: Macmillan Press.

Ichniowski, C., K. Shaw & G. Prennushi, 1997, The Effects of Human Resource Management Practices on Productivity: A Study of Steel Finishing Lines, *American Economic Review,* Vol. 87, No. 3, pp. 291-313.

Laursen K. & V. Mahnke. 2001. Knowledge strategies, innovative capacity and complementarity in human resource practices. *Journal of Management* and Governance, Vol. 1, No. 1, pp. 1-27.

Mahnke, V. & M. Venzin. 2003. Governing knowledge teams in the MNC. Management International Review, Vol. 43, No. 3, pp. 23-47.

Mahnke, V. & T. Pedersen. 2004 (eds.). *Knowledge flows, governance, and the multinational enterprise*. Basingstoke: PalgraveMacmillan.

March, J.G. 1991. Exploration and exploitation in organizational learning. *Organization Science*, Vol. 2, No. 1, pp. 71-87.

McDermott, R. 1999. Why information technology inspired but cannot deliver knowledge management. *California Management Review*, Vol. 41, No. 4, pp. 103-117.

Milgrom, P. R. & Roberts, J. 1992. *Economics, organization, and management.* Englewood Cliffs, NJ: Prentice-Hall.

Milgrom, P. & Roberts, J. 1995. Complementarities and fit strategy, structure, and organizational change in manufacturing. *Journal of Accounting and Economics,* Vol. 19, pp. 179-208.

Nonaka I. & I. Takeuchi. 1995. *The knowledge creating company*. New York: Oxford University Press.

O'Dell, C. & C.J. Grayson. 1998. *If Only We Knew What We Know: The Transfer of Internal Knowledge and Best Practice*. New York: the Free Press.

Osterloh. M. & B. Frey. 2000. Motivation, knowledge transfer and organizational forms. *Organization Science,* Vol. 11, No. 5, pp. 538-550.

Ouchi, W.G. 1980. Markets, Bureaucracies, and Clans *Administrative Science Quarterly*, Vol. 25, No. 1, pp. 129-141.

Rigby, D. 2001. Management tools and techniques: a survey, *California Management Review*, Vol. 43, No. 2, pp. 37-49.

Sanchez, R. & A. Heene. 1997. *Strategic Learning and Knowledge Management*. Chichester: Jon Wiley & Sons Ltd.

Sarvary, M. 1999. Knowledge management and competition in the consulting industry, *California Management Review*, Vol. 41, No. 2, pp. 95-107.

Spence, A.M. 1973. Job market signalling. *Quarterly Journal of Economics*, Vol. 87, No. 3, pp. 355-77.

Simonin, B. L. 1999. Ambiguity and the process of knowledge transfer in strategic alliances. *Strategic Management Journal*. Vol. 20, No. 7, pp. 595-623.

Teece, D. J. 1998. Research directions for knowledge management. *California Management Review*, Vol. 40, No. 3, pp. 289-292.

Toffler, A. 1990. *The third wave.* New York: Bentam Books.

von Krogh, G., K. Ichijo & I. Nonaka. 2000a. *Enabling Knowledge Creation: How to unlock the mystery of tacit knowledge and release power of innovation.* New York: Oxford University Press.

Wenger E. & W. Snyder. 2000. Communities of Practice: The organizational frontier. *Harvard Business Review*. Vol. 78, No. 1, pp. 139-145.

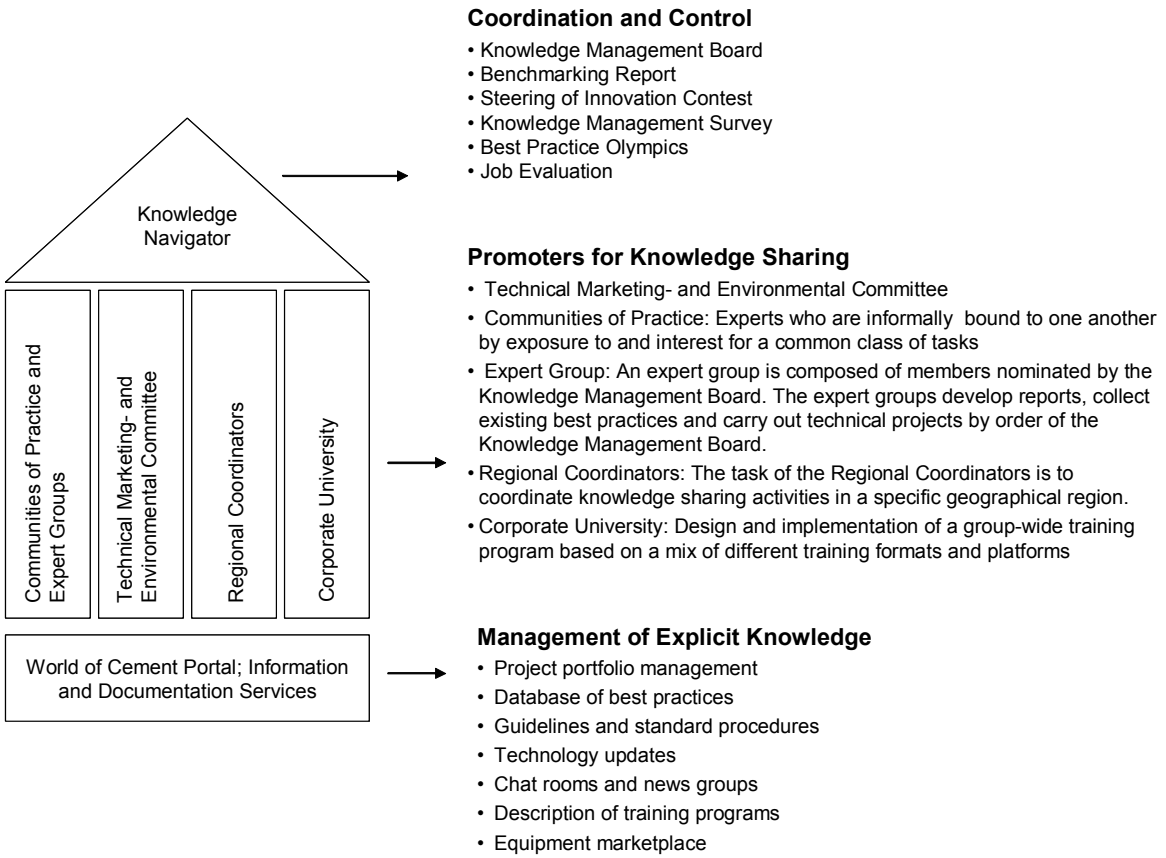

Figure 1: HC knowledge management Model

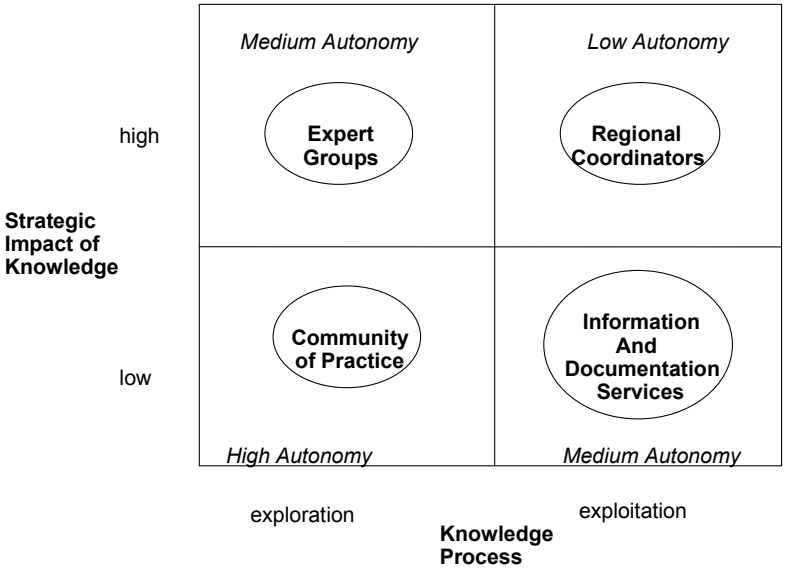

Figure2: Governance of Knowledge-teams in the MNC