In: Studies in Informatics and Control, 11 (2002) 1, pp. 7-15.

Barriers in Knowledge Management and Pragmatic Approaches

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Keywords

knowledge management, barriers, pragmatic approaches, methods

Summary

Corporate knowledge is nowadays well accepted as a decisive asset in most European enterprises. The know-how and expertise of the work-force is an important factor for the success of companies and strongly influences the effectiveness and efficiency of the business processes and their outcome. In engineering KM is specifically relevant due to the knowledge intensive character of the new product development process, which is an innovative and a non-repetitive process per se. However, today's practice in KM still lacks from significant drawbacks and the potentials of KM are capitalised only to a small degree.

Knowledge can be seen as the entirety of cognitions and abilities which are used by individuals to solve problems. This comprises theoretical perceptions as well as pragmatic day-to-day rules and guidelines and is an organised set of statements of facts or ideas, presenting a reasoned judgement or an experimental result. KM comprises any process or practice of creating, acquiring, capturing, sharing and using this knowledge, wherever it resides, to enhance the learning and performing in organisations.

Along with the processes of knowledge management many barriers exist, thus turning the management of knowledge into a very challenging task. A barrier for Knowledge Management can be considered to be „Everything related to human, organisational and/or technological issues that obstructs the intra- and inter-organisational management of knowledge ….“ [10]. Therefore, these barriers can basically be allocated to the TOP (Technology, Organisation, People) categories of socio-technical systems classification according to Brandt/Hartmann [9].

This paper aims to identify barriers in KM as well as pragmatic approaches in the engineering domain to overcome these barriers. Three cases will serve as examples for presenting benefits and drawbacks.

0. Introduction

Corporate knowledge is nowadays well accepted as a decisive asset in most European enterprises. The know-how and expertise of the work-force is an important factor for the success of companies and strongly influences the effectiveness and efficiency of the business processes and their outcome. The concept of Knowledge Management (KM) receives high strategic attention across multiple sectors. In the engineering area, KM is specifically relevant due to the knowledge intensive character of the domain. The new product development process, which is an innovative and a non-repetitive process par se, is especially interested in learning from the lessons of the past.

Knowledge can be seen as the entirety of cognitions and abilities which are used by individuals to solve problems. This comprises theoretical perceptions as well as pragmatic day-to-day rules and guidelines and is an organised set of statements of facts or ideas, presenting a reasoned judgement or an experimental result [1]. KM comprises any process or practice of creating, acquiring, capturing, sharing and using this knowledge, wherever it resides, to enhance the learning and performing in organisations [2].

Probst/Raub/Romhardt [1] provide a straight forward and easy to understand model (the so called "Building Blocks of Knowledge Management") for the description of the processes of knowledge management (see Figure 1). However, while applying this model within the EU funded research project CORMA (Practical Tools for Corporate Knowledge Management), the authors identified that, especially in the engineering domain, the aspect of "structuring" knowledge seems to be of high relevance for Knowledge Management. Thus, for the sake of the project, the model was adapted to the specific needs of engineering by adding an additional building block (see Figure 1).

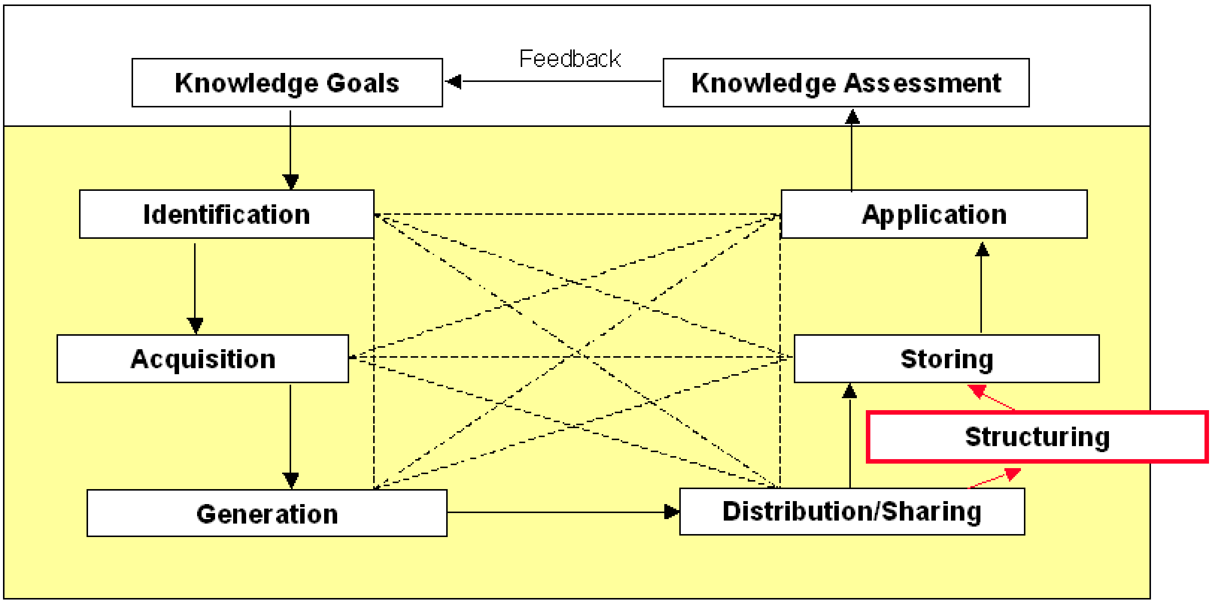

Figure 1: Adapted building blocks of knowledge management

1. Barriers in Knowledge Management

Along with the processes of knowledge management many barriers exist, thus turning the management of knowledge into a very challenging task to do (see Figure 2). A barrier can be considered to be „Everything related to human, organisational and/or technological issues that obstructs the intra- and inter-organisational management of knowledge ...." [10]. Therefore, these barriers can basically be allocated to the TOP (Technology, Organisation, People) categories of socio-technical systems classification according to Brandt/Hartmann [9].

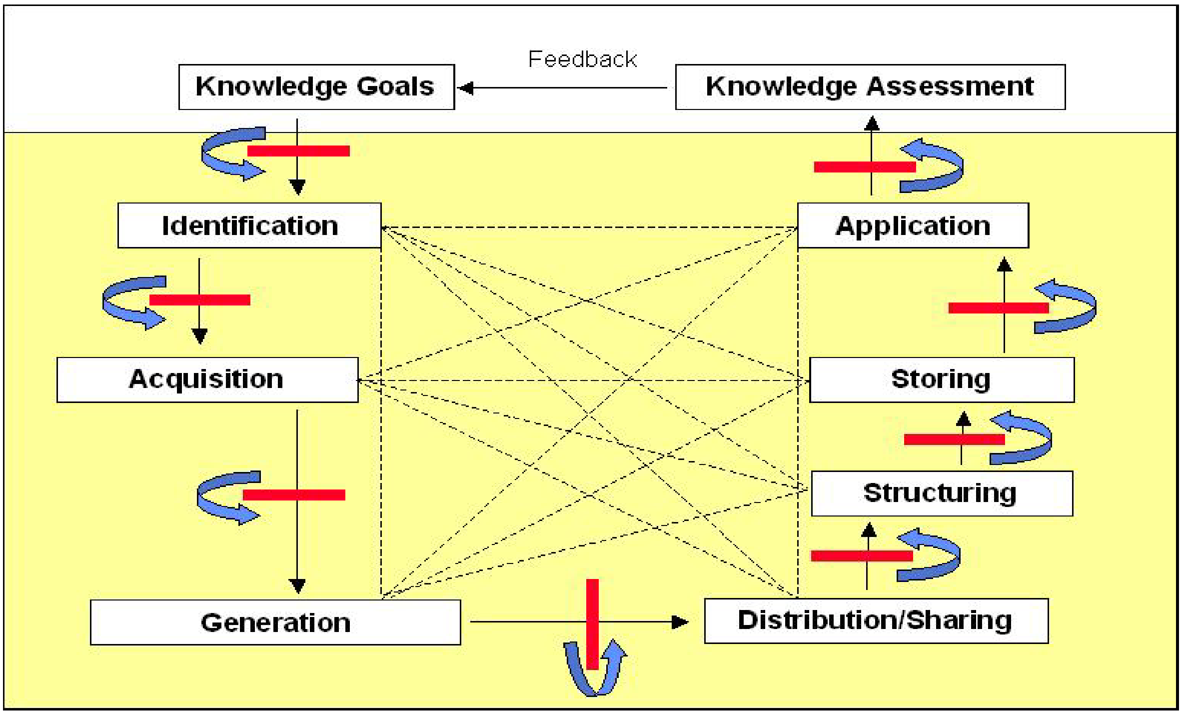

Figure 2: Barriers to knowledge management

In the CORMA project it was identified that companies generally considered technology to be one of the most important enablers of knowledge management. However, barriers related to the category Technology were not considered to be as relevant as those related to the categories Organisation and People. In the following some of the most relevant barriers related to the three categories will be presented and described as they were identified in the project CORMA via personal interviews in four companies and the use of questionnaires distributed among additional 500 other companies of which about 50 companies answered. For further identified barriers please refer to [12] and [13].

1.1 Barriers related to Technology

Legacy systems and incompatibility: Legacy systems are often the cause for compatibility problems either company internal as well as company overlapping. The possibility of having different software systems automatically increases with the amount of communication partners. The possibilities to overcome this barrier are either the identification of a system according to the principle of the "lowest common denominator" or to invest in a technology that satisfies the needs of all partners involved.

1.2 Barriers related to Organisation

Lack of awareness of knowledge management strategies and instruments: The conscious handling of the resource knowledge still seems to be a big issue when talking about barriers to knowledge management. The necessary awareness for the management of knowledge still can be considered to be relatively low among the responding companies. No company had an explicit knowledge management strategy implemented, nor determined corresponding responsibilities. It was also mentioned that employees often look for quick fixes, and therefore fight the symptoms of a problem and not its cause. When questioning why people tended to look for quick fixes instead for lasting solutions efforts related to time and costs were almost always mentioned.
High investments: Building intensive partnerships with customers and suppliers requires significant amounts of time and money. Once this has been invested, there is greater reluctance to break up the alliance should the performance of the alliance be insufficient.
Unavailability of individuals*:* It was considered to be difficult to track people down when wanting to talk to them. This results in time delays by searching for a specific individual. A second barrier in point in this context, is not knowing who would be the best person to ask in certain cases.
Different working times: When dealing with partners from other countries different problems arise. Due to dispersed location of partners (i.e. Europe, Asia, North America) time differences often limit communication to a small time frame, and thus to indirect communication means. Video-conferencing which is considered to be an important communication mean could therefore fail in usage. Further,

labour time is organised differently in other countries (i.e.: lunchtime in Spain is much longer than in Germany).

1.3 Barriers related to People

Different languages: The language barrier was mentioned to be a problem when dealing with people from other companies either from the same country as well as from abroad. When dealing with international companies it was recognised that it can lead to misunderstandings if people do not speak a language with certain level of competence. It was mentioned that meetings are sometimes unproductive because the topics discussed were only half understood. A further problem in this context occurs when two colleagues of the same company and the same country are involved in the same project but belong to different domains. The understanding of what they are talking about can be significantly different.
Fear of penalty/fear of losing profile: The presentation of not clearly defined ideas ("soft ideas") is often considered to be a weakness, thus reducing the space for creative thinking and the creation of synergies to develop ideas.
Idea robbery: This barrier describes the fear that the idea of an individual employee could be taken by another who than gets the acknowledgement and rewards for that idea. It implies the need for the protection of proprietary knowledge among employees.
Fostering established communication channels: As the same as on a intra organisational level, communication channels between colleagues across different companies must be maintained and fostered, thus resulting in high efforts. Since the establishment of good relationships is very time consuming, means must somehow be provided to support this task.

2. Pragmatic Approaches to Knowledge Management

Companies often try to tackle the aforementioned barriers by buying and implementing costly and complex software tools hoping that these will serve the purpose of overcoming the identified problems. As the evolution of KM is driven strongly by large enterprises and consulting companies, the proposed solutions are often rather complex and dominated by information technology (IT). However, Malhotra [3] reports about different studies in which no direct correlation between IT investments and business performance or knowledge management was identified. He emphasises that the organisational processes and the way the employees communicate and operate through the social processes of collaborating need more attention. Davenport and Prusak [4] report that some Japanese companies have installed so called "Talk Rooms" in which scientists come together to have a cup of tea and talk to each other for about half an hour. There is neither an agenda nor schedule and the only target is to bring these people together to evoke a discussion about their current work and to exchange ideas, thus leaving the generation of new ideas up to chance.

2.1 Characterising Pragmatic Approaches

Extending this statement, the authors would like to take the position that small pragmatic solutions are often as effective as high IT investments [5]. Therefore the aim is to exploit the already existing systems as far as their functionality allows. Secondly, the complexity of problems has to be reduced.
The underlying philosophy of a pragmatic approach can be characterised by following phrases which can be seen as guidelines as well:

- "A bird in the hand is worth two in the bush!"
- "Stop talking, start walking!"
- "To make a mistake is better than to make no experience!"

Accordingly pragmatic solutions are aiming at a 80-90% solution for an identified problem instead of a 100% solution. The remaining 10%-20% are either postponed for future activities or are not solved at all, because of the undue efforts which are necessary to achieve the needed results.

Based on a number of projects in the field of KM in engineering design the authors are convinced that a "controlled neglect" of certain aspects of a problem is reasonable for many industrial applications. This controlled neglect is implicitly embedded in the Pareto-principle (better known as the "80/20-Principle"). This principle was recognized by the Italian economist Vilfredo Pareto at the end of the 19th century and first published in 1897 [6]. It basically says that, out of a given group of elements, already 20% of them will yield 80% of the results.

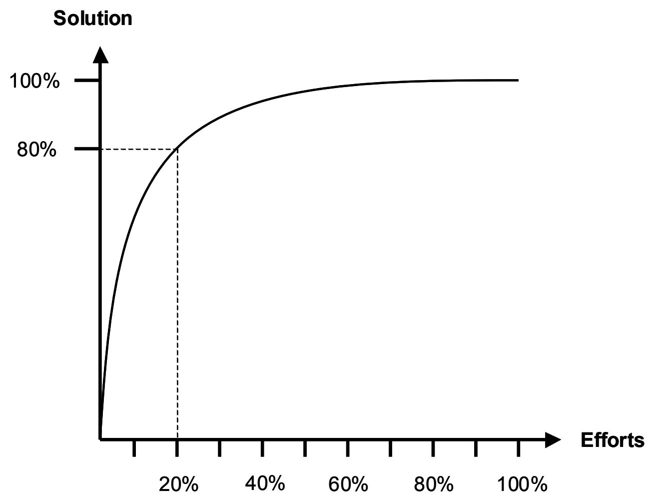

Figure 1: Pareto principle: Performing 20 % of the effort will lead to 80% of the results

A well known application of this principle is the ABC-Analysis which is often used as a time/task-management tool. Various examples on how the 80/20-Principle can be applied are given in [7].

The most relevant characteristics of pragmatic approaches can be summarsed as follows.

- intuitively applicable by the user
- fast and easy to implement
- active participation of the users in the definition phase
- common added value to be achieved in the short term
- application of a stepwise (evolving) approach
- are self promoting due to the short term benefit and thus can pave the way for larger follow-up solutions (if felt necessary)
- low costs

3. Application of Pragmatic Approaches in Knowledge Management

In the following 3 different applications of pragmatical approaches to Knowledge Management are described.

3.1 Managing Knowledge within a Process Chain of Formed Sheet Metal Parts

A pragmatic approach to knowledge management was chosen at a manufacturer of formed sheet metal parts for small series. Figure 3 shows the process chain from tool design until the finishing of the sheet metal parts: based on the product specs. a tool has to be designed and manufactured in various process steps: casting, milling, finishing, etc. In the last step the tool is used to manufacture the formed sheet metal parts. As the various process steps need specialised resources the shop floor is organized according to the process chain into so-called manufacturing “cells” or “units”. Knowledge about problems and related solutions identified during the process was documented in problem and solution reports according to the needs of the individual manufacturing cells. Available knowledge of the other cells as well as the needs of the other cells were not considered while documenting the knowledge of a cell. Accordingly improvements in quality, time and costs of the overall process were limited. Feedback from one process step to an earlier one was limited as well. Knowledge how to avoid problems in the manufacturing process and how to support a design for manufacturing (DfM) was available in general, but not for the designers. Forced by their customers to reduce lead-time and increase quality the company had to redesign the information management along the process chain.

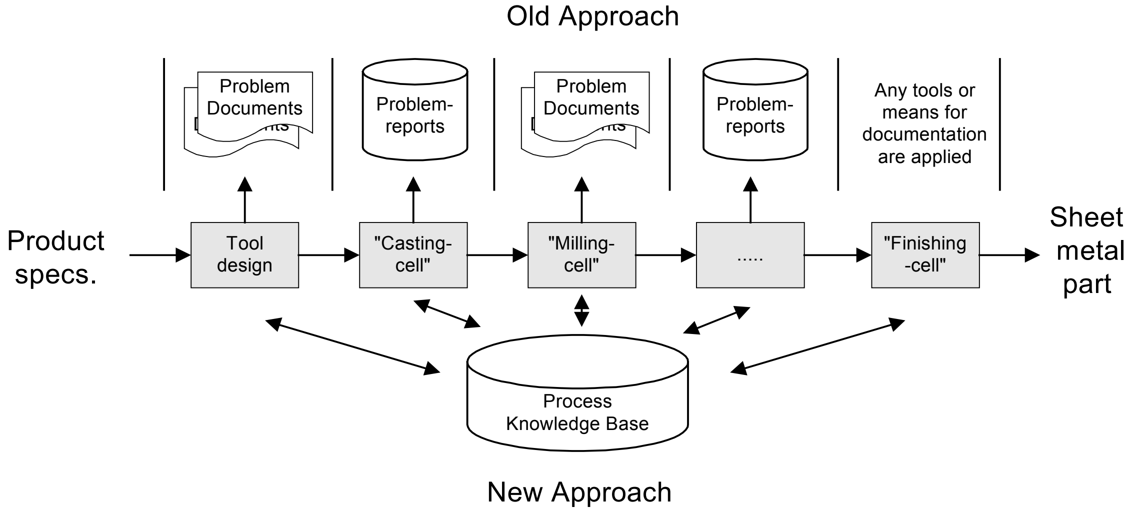

Figure 3: Management of knowledge in a process chain for formed sheet metal parts

The overall approach was to form a task force including product designers, tool designers and representatives from all manufacturing cells involved in the process chain, to discuss the mutual needs, the problems, and the challenges of all steps of the chain. Based on a better understanding of each other, inputs and outputs requested from the various cells were defined and the overall process knowledge was structured. In many cases, changes were required compared to the old approach and compromises were made in order to achieve a pragmatic solution, e.g. people agreed on having a 90 % solution instead of a 100 % solution which would have required far more effort.
A second pragmatic element in the approach was that the solution was implemented in the short term as a paper based KM system. Following an incremental approach, the first step was to start with a so called "tool file", which was handled manually along the process chain from cell to cell. Within the tool file (which had an agreed format) problems, related solutions etc. were documented. In parallel, the development of the computerised "Knowledge Base" has started, so that in future problems, related solutions as well as other „experiences" gained in the various steps of the process will be documented along the whole chain from tool design until the assembly of the sheet metal parts. Even by introducing the paper based, but commonly agreed tool-file, the number of reliable feedbacks from manufacturing to design increased significantly.

Table 1:Summary of Case 1

Problem	Pragmatic Approach
Insufficient communication and coordination along the process chain, caused by the application of the so-called "Throw it over the wall"- approach.	Specification of rough but commonly agreed documentation forms. Incremental Approach: From an early implemented paper based solution to a database application. Forms were made accessible for all employees involved in the process chain by an Intranet application.

3.2 Management of Design Knowledge between Design and Assembly

Considering the lifecycle of products, assembly activities are "far away" from design activities. This causes various well known problems in engineering design:

- After the design, a feedback from the assembly is – if ever – available only several weeks or months later.
- As the documentation of problems is time consuming and represents an additional activity for the people in the assembly area, their motivation is limited.

However, aiming at high quality products experiences gained in the production and assembly process have to be made available for the design of new products. In parallel, the time and efforts needed for documentation have to be minimised and just-in-time documentation has to be realised. Additionally ideas about optional solutions, anticipated problems, as well as identified problems have to be described in such a way, that it is easy for the designers to understand.

The approach chosen in the company was to create a close link between the design department and the assembly area by installing an Intranet application on the one hand, and by offering various digital cameras to all departments dealing with the manufacturing and assembly on the other hand. Pictures made with the digital camera are stored in a database and are being made available to the design department via the Intranet application. So far a textual description has to be typed to describe the problem documented by each specific picture. However, by applying this approach, time consuming documentation activities were avoided and the response time for feedbacks from assembly to design was minimized.

This case serves as a good example for distinguishing pragmatic from non-pragmatic solutions: The distribution of digital cameras including the instruction to manually typing in the problem can be regarded as pragmatic because it used a straightforward approach and mature and easy to use technology[1]. The introduction of technologies like e.g. speech recognition, automatic picture processing and indexing would have been beyond pragmatic approaches as these are not yet fully mature and need careful adaptation and fine tuning. Thus the proposed 80% solution was prioritised compared to the 100 % that would perfectly fulfil the needed requirements.

Table 2: Summary of Case 1

Problem	Pragmatic Approach
Insufficient feedback of problems and experiences identified in the assembly area to design department	Easy to use technologies (digital cameras and Intranet) for a quick documentation of problems and failures.

3.3 Approaches to KM in a R&D Department

The following case provides a brief outline about different pragmatic approaches for KM which have been implemented successfully in a R&D department of an organisation with a staff of 150, comprising engineers of various domains, as well as technical and administrative staff. Major objective of all activities was to reduce the knowledge loss when experienced colleagues leave the organisation, to speed up the learning curve for novices, and to increase the knowledge exchange between the individual, multidisciplinary experts. The measures were addressing both knowledge about complex engineering issues e.g. methodical research/development approaches etc., as well as small day-to-day business processes as e.g. business travels or specific email problems. The following measures were implemented (among others):

- *Personnel Coaches* (Mentors): When entering the organisation, each novice, e.g. a junior engineer, is assigned to a personnel coach who is responsible for introducing the novice to the colleagues, the business processes, and the future working domain. The coach must have already stayed in the organisation for at least 2 years.

- *Round Table*: The engineers involved in the development process meet regularly (3-4 weeks) for exchanging their current design challenges and problems. The round table is accompanied by smaller means as e.g. a knowledge map of the engineers or an internal newsgroup for short term problem discussions.

- *Common directory structure*: All engineers store all their files in a common directory structure on a server. No files related to a project must be stored on the individual hard disks. The structure comprises predefined directories for e.g. projects, acquisition (bids), old projects, general department issues, or individual users. The structure is predefined up to four levels (for a detailed case description cf. [8]) which was identified as sufficient for most of the projects. A cost benefit ratio for this measure was exceptionally high, also because no IT investment for its implementation had to be made (because servers were already existing).

- *House of Competence*: A competence matrix (portfolio) describing the competences of all engineers in a systematic and “easy-to-use” way. This matrix supports the strutured identification competent colleagues for both nivices as well as (see Figure 4).

- *How To’s*: A variety of guidelines and recommendation is made available voluntarily on the Intranet by ‘knowledge owners’. These range e.g. from where to take project partners to dinner,

[1] The authors assume here that the corresponding processes were well defined, i.e. that it was e.g. specified how the designers make use of the picture database.

via how to prepare project meetings, up to how to configure the email system. These recommendations are intentionally placed outside the organisations' formal Quality Management Handbook following ISO 900x. (This approach can be compared with a self-organized concept of FAQ (Frequently Asked Questions)).

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Programmiersprachen												
ANSI-C	x		x	x			x		x	o		
C++	o		o+	x			o		o	x	x	
Delphi												
Java	o+		x	+			o			o	o	
Borland Jbuilder			x									
IBM Visual Age			+									
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JDK (Java Development Kit v. Sun)	o		x	+			o			o		
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Oracle			+	o			o			o		
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JDBC			+							o	o	
LDAP			x									
Verteilte Objekte												
Corba	+		+		+		+			x	o	
EJB (Enterprise Java Beans)			o+									
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JSP (Java Server Pages)	+		+				+					
PHP3/4			+			+	o					
Servlets	+	+	o	+	+		+		+		o	
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XML (eXtensible Markup Language)	+	+	o+	+	+	+	o	+		+		
Setups												
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Figure 4: House of Competence

All measures are in operation since 2 years (except for the round table which has been implemented only 3 months ago). All measures allow small individual or case specific modifications and assure short term benefits for the users. Common to all approaches was the utilisation of the existing IT infrastructure. For some of the approaches, also larger solutions had been in discussion, but these were rejected for the benefit of a fast, flexible and simple implementation. Also, all approaches have been planned and implemented by the employees themselves.

Table 3: Summary of Case 3

Problem	Pragmatic Approach
Flat learning curve of novices	Personnel coaches
Lack of communication of non project specific information and knowledge	Programmers Round Table
Identification of knowledge "hidden" in other projects	Specification of identical directory structures up to the fourth level for all types of projects. Further detailing of the structure would have generated to high efforts
Time consuming no value adding tasks related with project management activities. Frequent disturbance of experts related to tips and tricks requested by colleagues	Documentation and provision of "How to´s" on the Intranet

4. Conclusions

Describing several barriers in knowledge management the authors identify that the relevance of barriers related to human aspects prevail. In contrast to usual approaches to knowledge management in which the implementation of ICT infrastructures play a central role, the authors have applied the concept of pragmatic approaches for KM considering industrial cases related to engineering design. As described, pragmatic approaches are based on a philosophy which prefers to implement 80-90% solutions in the short term instead of a 100% solution in the long term.

Three exploratory cases have been presented and the achieved benefits have been discussed. These are mainly the possibility to achieve working KM solutions in the engineering design environment in a short implementation time and with reduced costs for IT investments.

As no direct correlation between investments of time and money in new technologies on the one hand and an increase of productivity of a company on the other hand can be identified according to Malhotra [3], investing time and money solely in technology has to be considered to be short sighted, especially when aiming to overcome the barriers in knowledge management. According to [14] this so called "productivity paradox" can be explained by various arguments of which two shall be discussed here for the purpose of supporting the concept of pragmatic approaches proposed by the the authors:

- *Insufficient reorganisation of company processes*: the implementation of new technologies in company for the mere sake of modernism will probably lead to high investments without making use of the full potential of such technologies. Therefore, companies should tend to better exploit available resources. Further, the application of technology, independent from being new or old should always be considered together with human and organisational aspects.

- *Resistance against renewal*: Employees usually tend to have a natural resistance against changes [11]. If to many aspects in their environment are changed at the same time they feel insecure and will probably not co-operate with the change inducing power. In the case of the productivity paradox the resistance will arise when new technologies are introduced and along with it organisational changes. Thus, the authors conclude that instead of solely looking on the introduction of new technologies to solve problems in knowledge management, companies should also focus on simple organisational or methodical measures. Probably a smooth approach to KM is the key for the introduction of further KM measures. In order to accustom the employees to the philosophy of KM managers should prefer 80% solutions for the sake of acceptance and the willingness to introduce further measures.

Deriving from the three presented cases as well as from the possible reasons for the so called "productivity paradox", the authors conclude that a highly participative approach (i.e. direct involvement of concerned employees) is of utmost importance for the acceptance of any solution in this particular area.

However, pragmatic approaches in general also bear a strong risk. People may be tempted to implement the first solution they see without carefully reasoning about its appropriateness and usability. If KM solutions aiming to support a better cooperation between design and manufacturing fail, it gets more difficult to motivate the users to participate in a second approach. Thus – in contrast to trial and error solutions – the potential error must be avoided as far as possible. Accordingly incremental approaches are far more promising than large and not controllable steps. The authors assume that a sound conviction about the appropriateness of a solution is a critical success factor for the successful implementation of pragmatic approaches in engineering design. In order to exploit pragmatic approaches with a reduced risk, future research should aim to develop methods and tools for KM which allow for the identification of the most relevant aspects to be addressed by pragmatic solutions.

Acknowledgement

This work has been partly funded by the European Commission through IST 1999-12685: CORMA – Practical Methods and Tools for Corporate Knowledge Management. The authors wish to acknowledge the Commission and the project partners for their support.

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