SUPPORTING RESEARCH AND DEVELOPMENT PROCESSES USING KNOWLEDGE MANAGEMENT METHODS

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Session L-5

Abstract

Actually companies have to concentrate on their own core competencies to compensate the pressure coming from the market and the increasing complexity of processes, products or surrounding environment. Modern companies are specialized on similar fields and form work groups, work lines or even companies for this. Specialization means in this context: on the one hand high qualified employees and very special know how, but on the other hand a large amount of communication work. A holistic view and a long term plan are necessary to achieve such ambitious goals like knowledge management in a diversified or spread company. Our case shows the successful co-ordination of project handover and collaborative knowledge production between development and production division of Trumpf Maschinen Austria.

Keywords: Case study, knowledge processes, communities, cooperative learning.

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Suggested track: L Practicioner's Track

1   Introduction

Trumpf Maschinen Austria (TAT) was founded 1990 near the city of Linz, Austria as an independent subsidiary of the Trumpf group. TAT is a competence center for press brake and bending technology and produces TrumaBend® press brakes, the TRUMPF BendMaster® and laser-hardened bending tools.

TAT had a turnover of 94.5 Mio EUR and employs 168 people. Two thirds of produced CNC machines are exported world wide. Main focus of R&D is on the process chain of "Blech" (sheet plates).

Currently three TrumaBend press brakes are delivered every day and production capacities are in the process of being expanded to be prepared to meet the constantly increasing demand for TRUMPF press brakes in future, too. Tool machines and production technology by TAT are in a leading position on the world market.

2   Setting the Stage

The following case study is based on an information and communication problem between the Research and Development (R&D) department and the Construction department of a large machine manufacturing company with subsidiaries all over the world.

2.1   Problem details

In the past the development of new machines was done in one big department (the "construction") which also had to handle customer orders. Knowledge and experience transfer from R&D activities to order processing was and integrative part of daily business.

Later on the fast growth of the company led to less R&D activities and required the split into an R&D department and a Construction department. The R&D department was then responsible for the development of new machines and the construction department had to process customer orders, which means that in this department special needs of the customer concerning a machine had to be implemented within the general technical specifications.

Now the big challenge is to handle the transfer of knowledge and experience produced in the development projects within the R&D department to the Construction department which has to use the project results when processing customer orders. So the overall target of a new concept for exchanging and sharing knowledge and experience is to include know-how and experiences of all departments of the company within development projects.

2.2   General conditions

Development projects in this company are of highest complexity and last up to two years. A development in this context is defined as a project that develops a machine type in several similar specifications. Additionally the machine manufacturing company required that a new concept should support

- integration of know-how of all company departments (e.g. Sales, assembly, production)

- reduction of the cycle-time for a machine development projects

- serial production has to start right after finishing the R&D project

- providing up-to-date information about R&D projects for all employees

and also should be complementary to an overall "integrated product development process" which was worked out and applied in this company.

3 Case Description

To solve the problem described above a new concept concerning exchange and transfer of information, knowledge, experience and know-how had to be developed.

3.1 Current State Analysis

During the current state analysis the existing „integrated product development process as well as the split of functions among the departments was analyzed. Additionally the employees' concerns have been integrated during an online-survey about special topics, which was qualified completed by 35 employees out of several department, which was a very good result (47 employees had got an invitation). Some completed questionnaires made no sense so they had to be ignored.

Results of the current state analysis were:
- no clear work order between development and construction
- demand for an increase of informal communication to foster the exchange
- employees think, that the workload of their own and their branch is very high
- a structured project result handover is needed

As major point of the survey the project handover between development and construction division had been analyzed in a more detailed level:
- delivery of project results can be done by exchange of documents, but parts must be supported by communication or discussion processes
- on principle all results and interfaces of components or assembly groups are described as complex and time critical (for the delivery process)
- results about new technologies are also time consuming at the delivery
- the employees are positive motivated to use a project management tool as support of the delivery
- the construction division should be informed about the current status and content during the project, to be able to bring in it's know-how for optimal results
- after the delivery there should be responsible persons at the development division for each technical aspect, for assistance at approaching problems

One important activity within this phase was to review existing knowledge management methods regarding their applicability within the context of this machine manufacturing company.

3.2   Action plan

In a workshop with the management team and the project managers the results of the analysis have been discussed and an optimized situation was drafted. This draft did not contain any idea about the new concept but it described the "to-be" situation within the company very clear. Derived from this "to-be" description, a list of main goals was prepared, which is divided into three major parts: organization/structure, information/communication and project management / documentation.

The optimization of the existing interface between development and construction can not be taken under consideration separately from other divisions of TAT. This means that there is a higher demand for structural and organizational handling of development projects. Following steps have been planned:

- definition of work distribution among involved divisions in development projects
- definition of specialized technical groups (a mixture of teams and communities of practice) for supporting information and communication in projects
- standardization of documentation and storage of project documents
- usage of a project management software

For a better information and communication during the project delivery the concept defined:

- support of informal communication of employees of both divisions (development and construction)
- formal communication to grant feedback and commitment of employees to official project documentation
- information of employees about on going development activities and current status of development projects

The last points of the concept handle project management and documentation. Main goal is the structured documentation of project results. To reach this we planned:

- common vision and mission in the project management
- structured way of delivering project results

3.3 Concept overview

To solve the existing problems, the concept is oriented along the integrated production development process of TAT (see Fig. 1). The integrated development process follows the defined process for development of new products which is based on the strategic development program. The strategic development program is defined by the management. A product or product family is then derived from this program, and afterwards it is worked out in more detail in the development division.

As described in Fig. 1, the concept consists out of five main phases, from which some are partly overlapping. These overlapping parts are necessary to handle preparation activities (ex. planning workshops), although the actual phase isn't completed. Phases I (Initializing), II (Development) and III (Transfer) are focused on the product development process and the ongoing interaction of all included divisions (development, construction, production). Phase IV (production support) accompanies the whole development project and contains activities and measures to support tasks which are performed in phases I, II and III. Caused by the identification of optimization potentials beside the interface of development and construction division, we developed phase V (project independent activities) which contains activities and measures to increase transparency and information transfer in the whole organization.
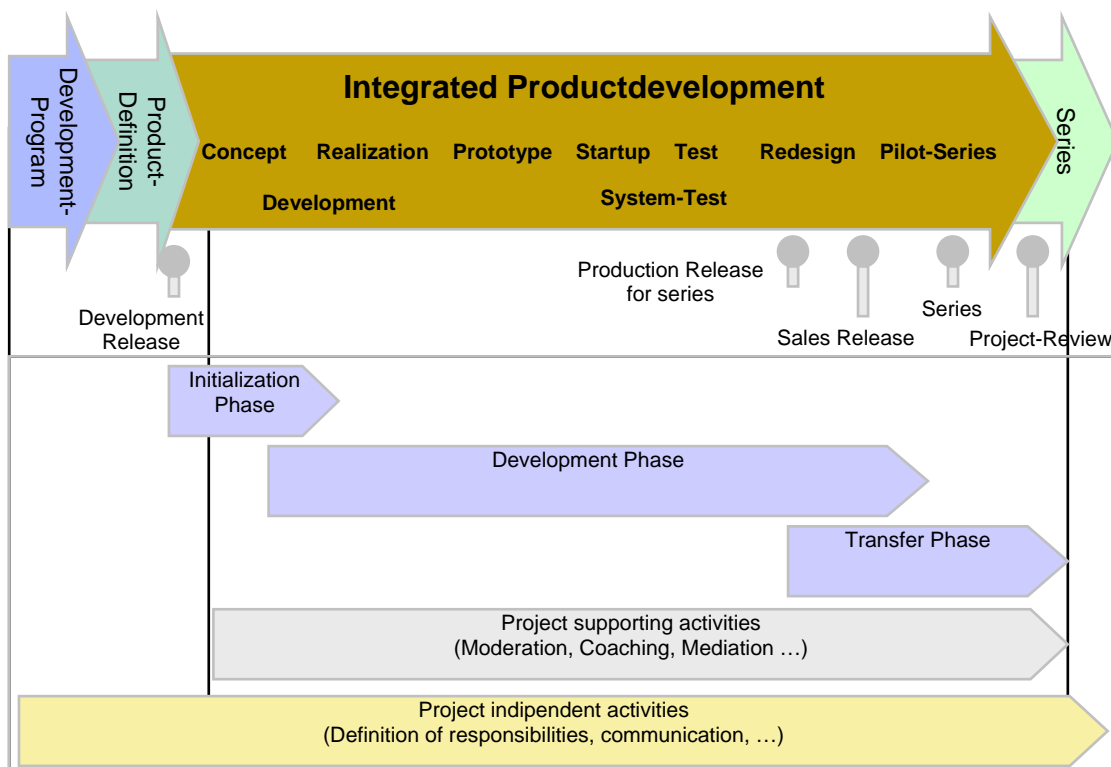
Fig. 1: Concept overview

Following chapters will describe the five phases of our approach and the included measures in more detail.

3.4 Procedure model in detail

Fig. 2 shows a closer look on phases I and II. Special task is here the *target definition workshop*, which is responsible for the definition of knowledge goals, responsibilities, exchange and feedback, information and communication tasks which are necessary for project execution.
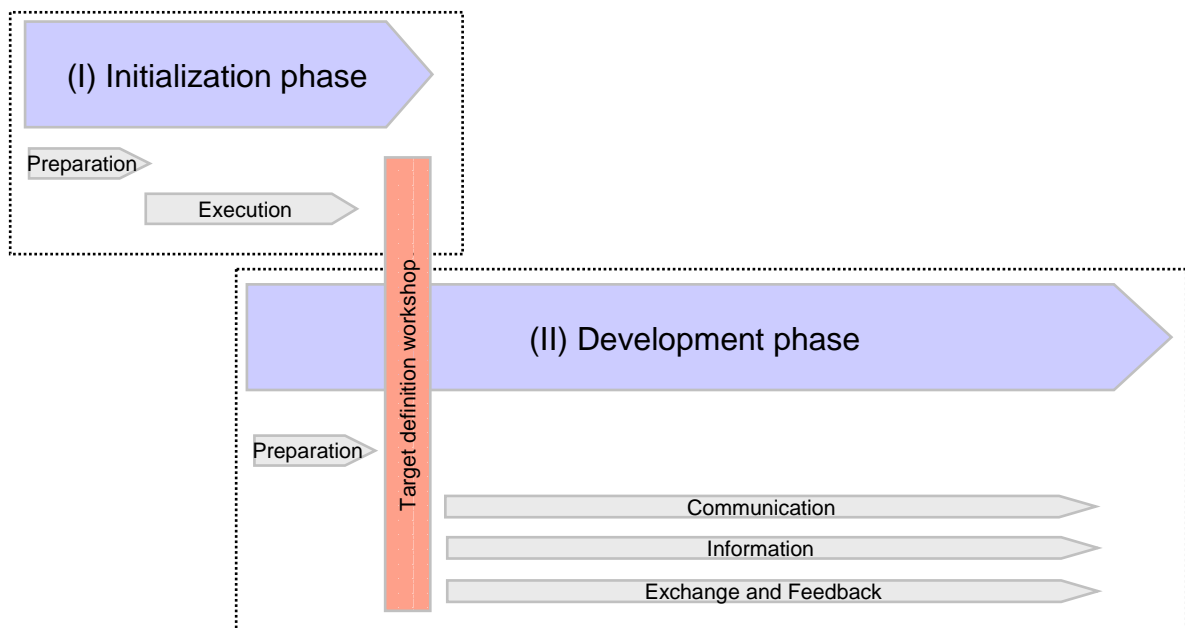

Fig. 2: Concept Detail – Part 1

Initializing Phase (I) handles all preparation activities for the execution of the development phase, which starts overlapping with it. Preparation means securing ongoing information exchange, communication and exchange of experiences between all participating divisions.

Subphase 1 – Preparation: In this subphase the project manager of the development project prepares a presentation of the idea behind a new product (ex. machine or new series), which contains the news and makes the differences to actual products more transparent.

After this the project manager holds the presentation in front of leaders and experienced employees of all divisions of TAT to get a first feedback. This also fosters first discussion processes among employees and guarantees an equal information level, which is highly important for the motivation of the employees (Davenport, 1998).

The second important activity of this sub-phase is the creation of a concept presenation, which can be done after finishing the concept-subphase in the integrated development process (see Fig. 1). The presentation contains the most important facts like technological requirements, newings or complex elements.

Subphase 2 – Execution: This sub-phase handles the execution of all presentations, which are not part of the target definition workshop. Main idea beside the equal information level and discussion processes is the identification of the employees with "their" machine.

Target Definition Workshop. The preparation of the *target definition workshop* is done in sub-phase 1 of phase II – preparation. Content of this workshop is the definition of so called "knowledge goals". These knowledge goals are relevant for co-work of different divisions within the development project. Result of the workshop should be a way which secures the communication, information and experience exchange and feedback between the employees of these divisions. It is NOT goal of this workshop to work out technological requirements, because these are defaults defined by product-idea and concept of the new machine (series).

Participants are all "heads of units" and selected employees (if possible opinion leaders) of participating divisions. The participants document their commitment by signing the protocol of the workshop.

As another result out of this workshop technical groups are defined to build up project supporting structures and activities. Special technical groups could be electronics, mechanics etc., which handle a smaller field in the development process. All defined goals are tracked with adequat measures in the development phase.

The development phase (III) is of main importance for the successful implementation of the procedure model, because in this phase happens the interaction of all participating divisions. Substantial for this phase is the definition of knowledge goals in the target definition workshop.

The three sub phases (1 to 3) track the defined and committed goals out of the target definition workshop. This fosters an efficient co-operation, successive construction of know-how in all divisions, following after the development division, usage of know-how

of the following divisions and, last but not least, securing the ongoing information about the project realization of all TAT employees.

Subphase 1 – Preparation: As preparation work is already done before the target definition workshop, there is an overlapping part with sub phase 2 of the initialization phase. A suggestion for the workshop is to take an external moderator to work most efficient and target oriented. During this preparation phase the heads of units also select the participating members of their divisions.

Subphase 2 – Communication: Communication as meaning of active information transfer is established in group meetings and an electronic project management tool. Van Heijst et al. (1998) described the act of organizational learning trough communication. As you can see in Fig. 3 the communication of experience brings an increase of organizational knowledge.
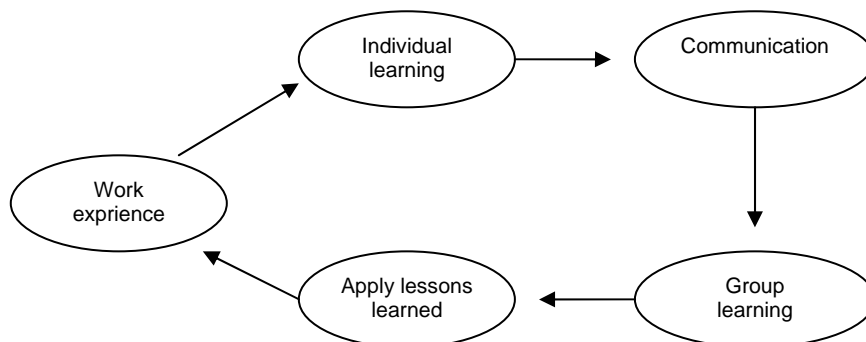
Fig. 3: organizational learning through communication (Van Heijst, et. al., 1998)

This constellation works for both ways of learning out of communication (van Heist, et al. 1998): supply driven and demand driven learning. In supply driven learning, the single employee gains experience and deeper know-how and communicates this to his colleagues. Demand driven learning describes the situation of an employee, who is searching for an answer for a specific problem or topic.

Fostered by the heterogeneous participants of such group meetings new and important information is very efficient spread to all divisions of TAT. The more formal communica-

tion is handled by a project management tool which is described in more detail in chapter 0. This tool secures the documented information broadcast and supports feedback rules.

Subphase 3 – Information: Based on committed information goals the project manager informs all participating employees by email about the actual situation of the project or further news. In parallel the same information will be published on posters or blackboards in all central areas (like kitchen, coffee machine, smoking area) to keep all employees informed.

Different to the communication phase is the fact that in this phase (information) the communication runs one-way. This is a push methodology. Goal is to spread information.

All group meetings are documented in a protocol which is published via the electronic project management tool to all relevant employees (mostly all participating employees), which grants that all involved people have the actual information about decisions, problems or facts.

Subphase 4 – Exchange and Feedback: The exchange process defines the interaction between all technical groups, to prevent information spots and lacks. In their group meetings the technical groups work out important elements of their special area of interest. Important elements are such ones, which are of a high complexity or are very time critical during the transfer between development and construction division. These elements are gathered in a structured collection which is periodically reviewed.

A possible instrument to increase the quality of work is to establish an internal (or if possible external) feedback group, consisting of experts or experienced people. The optional involvement of external specialists could be done by co-operations with universities or research institutes, which are an upcoming topic in Germany (Edler, 2003).

The results (relevant elements, part concepts, solution concepts or important experiences) of a technical group are sent to a defined feedback group. This group "reviews" the results and brings in their own opinion and also experience. Main goal is here to use synergies between the knowledge of different groups and also to avoid technological or organizational blindness.

Project and Result Transfer Workshop. Like described in Fig. 4, the concept includes also a workshop for defining how to transfer the project itself and special results between development division and construction division. This workshop initializes the transfer phase and must already be planned in the overall project plan. Main subject of the transfer workshop is the formulation of a detailed transfer plan. Participants are largely the same as in the target definition workshop.
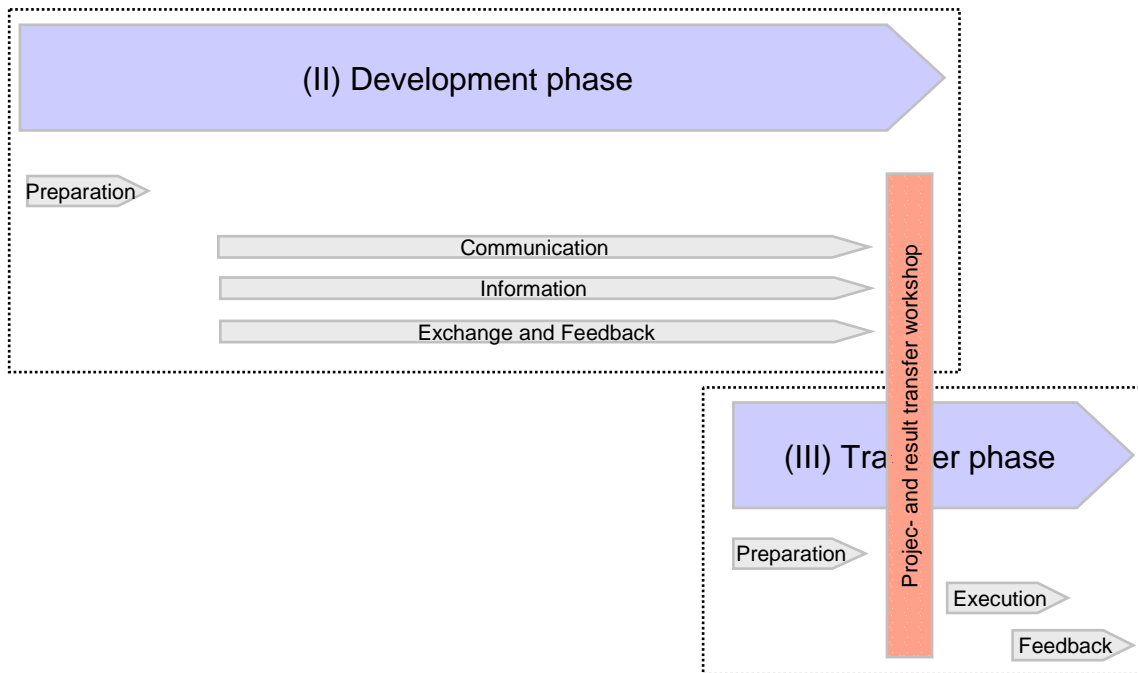

Fig. 4: Concept Detail – Part 2

A (external) moderator prepares afterwards a protocol and a transfer plan in digital media. Protocol and transfer plan must be committed by each participant of the workshop, which is done by using the project management software and its feedback functionality. The project transfer plan provides a summary of what, who, with whom, when, in which way has to be delivered. As instrument for planning, execution and control a transfer matrix has been developed, which is described more detailed in chapter 0.

A precondition of a successful application is the ongoing documentation of activities and results done by technical groups during the development process.

Transfer Phase (III). The execution of this phase grants the efficient transfer of project results to following divisions, like construction division.

Subphase 1 – Preparation: Like the preparation of the target definition workshop the preparation of the transfer workshop is overlapping the preliminary phase. The project manager plans with the (external) moderator the workshop to fix the essential points. Target is to grant that after the workshop a detailed transfer plan (consisting of what, who, with whom, when in which kind) is available.

Subphase 2 – Execution: The execution sub-phase handles mainly the implementation of the transfer plan and the documentation of occurring problems and responding solutions. To document this steps a transfer protocol is used.

Subphase 3 – Feedback: The sub-phase feedback is the final step of the co-operating project handling. Important for future projects is the documentation of gained experiences as outcome of the current development project. To grant the best possible re-use of experience it is necessary to collect "lessons-learned" of the technical groups, from the project manager and sub-project managers. This can be done by collecting special topics – like problem-solution combinations or by using a story telling "light" approach (or something like after action reviews). Resulting documents will be collected and provided in the project management software.

Very important to say is, that it is necessary to encourage or to "force" project managers to take a look into the "experience database" before they start a new project. This is a point to change organizational culture. Accepting know-how out of experiences others made. "*Moreover, they must clearly explain the rationale for their final decision, including why they chose to accept some input and advice while rejecting other suggestions. By doing so, leaders can encourage divergent thinking while building decision acceptance. (Roberto, 2002)*"

Project Supporting Activities (IV). Following measures could be defined as project supporting activities:

- establishing of technical groups
- organization of group meetings
- providing IT support
- creation of a standardized documentation and folder structure
- moderation, coaching, mediation
- information activities (ex. topic of week)

Information activities: As part of the information strategy the publication of special topics for a short period (a week) is done by publishing posters on blackboards or similar information points in central communication areas like coffee corners, buffet or smoking areas. A future idea could also be the establishing of "info-points" with special configured PCs accessing the intranet. Such information- and knowledge markets (Davenport, 1998) foster communication, information transfer and knowledge exchange concerning this special topic. The topic responsible person is the project manager.

Project Independent Activities (V). Following activities are defined independent from a running project and can be initiated every time:

- definition of a responsible contact person for each division
- supply of communication means
- clearly defined work distribution

The first two activities increase internal (and external) communication by providing methods and structures and another topic, pointed clearly out in the online survey, is the clearness of work distribution. A solution for the last point is a team around the head of unit, which describes the work of the division.

Definition of Contact Person for each Division: To increase the efficiency of communication, especially after delivery of machines which reached the maturity phase, it is necessary to define a responsible contact person per division. Additional the technical group agents could be defined as contact persons for the individual development topics.

Communication Means: To support informal discussions (which lead to the most creative solutions) it is possible to provide whiteboards or flipcharts in communication areas. Ideas could so be described more easily and worked out in more detail than only telling it. Additionally more people could take part in the discussion because it is documented.

3.5 Applied Knowledge Management methods

The achieve the final result of a knowledge oriented R&D process, following KM methods have been used and implemented: Teams and Communities of Practice [CoPs] (Wenger, McDermott, Snyder, 2002), Interface handling methods like workshops, early information system to create awareness, IT system support for decisions, information transfer and process documentation (Maier 2004). As final step a reflection step has also been integrated to get lessons learned and further improvements along the process.

Technical groups. These groups are a mixture of CoPs and teams, a semi open community with a more or less defined goal – development of special topics of a new machine (ex. electronics, mechanics). Like other constructs (CoPs (Lave, Wenger, 1991), Ba (Nonaka, Konno, 1998), communities of creation (Sawhney, Prandelli, 2000) or networks of collaborating organizations (Powell, Koput, Smith-Doerr, 1992) such technical groups are an extremely important issue for knowledge creation within a company.

Technical groups are no organizational unit. They consist out of participants out of *different* divisions (not only development or construction division) who are also involved in the topic of the group (ex. technical group for hydraulic systems). Technical groups should not exceed seven members to keep efficient (Fay, Garrod, Carletta, 2000).

Each technical group nominates an agent who acts as feedback responder. This means, the agent answers and comments all feedback inquiries of other groups. All other participants of the technical group will "only" be informed and deliver their comments to their agent.

Results and developments (including relevance) of technical groups are documented later on in the transfer matrix.

Organization of Group Meetings: To optimize the cross division information and communication it is necessary to institutionalize group meetings of technical groups. Each meeting should have a certain topic: development problem, -status, new technology, etc... These topics should be primarily suggested by development staff, and the other participants provide input and participate on discussions (bringing in their experience). Group meetings should be arranged periodically (ex. starting with one meeting per month at the beginning up to weekly). To keep the organizational effort per meeting small as possible the meeting organization could be done in a rotating system. The organization could be kept simple: agenda, reservation of meeting room, sending out invitations and documentation of meeting in meeting protocol.

Like CoPs technical groups share knowledge among different divisions and increase so the amount of knowledge carriers (not only one person, who could get lost) and also the organizational knowledge (institutionalization of know-how and best practices) (Van Heijst, et. al., 1998).

Project Management Tool / Software. IT support of development is split into two major parts: first is the project documentation (structured documents and folders) and second the project management software itself. All documents and templates for protocols are provided by the project management software, that's the reason for combining these points to one topic.

Creation of Standardized Documents: The creation of a standardized documentation and folder structure should increase the efficiency in project management. The structure provides information about the point of time when which documents have to be created and how the must be structured. To ease the access to these documents it is useful to create a project independent folder structure or to implement a document management system.

Implemented standard documents are:

- Feedback document: for feedback groups, to get feedback in structured and similar form.
- Status document: designed for ongoing overview about the project status and relevant results. This document is also used for the project information group. The project plan must contain points of time when such documents have to be created.

- Agenda and protocol templates for technical groups: for a consistent documentation.

- Transfer protocol template: for consistent documentation of project-result transfer among the involved employees.

Project Management Software: During the conceptual planning it was necessary to plan the application of the existing project management software. Like described above, the project management tool supports, additional to the provision of documents, information and feedback processes. To reach this it was necessary to implement following roles and dedicated functionalities:

- project manager: responsible person for project, who accepts document release

- project member: according field of activity in the development project these persons are responsible to provide and create documents

- technical group leaders: can create documents to inform their group and project members

- Project feedback group: consist of one agent per technical group. The members of this group must give their feedback to send out documents of project management, project members and other technical groups.

- Project information group: this group contains all other technical group members and employees who must be kept informed about the ongoing development activities. This is necessary to prepare early upcoming activities. This information process enables employees to keep a complete overview and it also initiates an informal communication about new developments.

Project Transfer Matrix. During the Transfer workshop the team fills the project transfer matrix, which is used for planning and controlling the transfer of the development project results. The matrix contains all necessary information for the transfer about elements, responsibilities and status. In detail the TAT matrix consist out of following columns:

Project steps: Contains all process steps which have been executed during the product development. This column is filled by the project members in the technical group meetings.

Executing division: the current step is managed and executed by division (XY), or in combination with division (AB).

Output: describes the output of the current project step

Status: current status of execution in percent

Transfer relevance: (priority) the definition of A (high), B (medium) or C (low) describes the importance of the transfer of this elements (and defines derived from this the order of the transferred elements).

Transfer complexity: the definition of A (high), B (medium) or C (low) describes, how difficult it is to transfer this element

Transfer responsibility: name of employee, who is responsible for transfer of this element

Transfer start: date, when transfer should start

Transfer end: date, when transfer should be finished

Status of Transfer (%): the transfer responsible person documents in this weekly updated column the transfer status. If a delay exists, the project manager is able to intervene.

Transfer protocol (yes/no): during the transfer workshop it is defined if it is necessary to create a protocol for this transfer element, because if the element is not important and there is only low complexity it is not always necessary to prepare a protocol. To prepare useless protocols would lead to less motivation.

Target division: division which gets output of current project step

Target responsible: employee of target division who is responsible for transfer

Notes: additional information for documentation: ex. reasons for delay.

The project transfer matrix is a highly vital document which describes not only the transfer process but also documents it.

4   Conclusions

Today, employees need not only physical material for their daily work, but also an increasing amount of information and knowledge. Codification of knowledge and dedicated sharing of this information is used for keeping knowledge within the company and to support all working steps where this information is needed. This requires also knowing more than one simple task for a further understanding of the whole process. Employees must be able to get more than a local view to notice barriers or critical inter-

faces to neighbour tasks. This consciousness enables innovation and further improvements on the process. The same is valid for divisions and their organisational borders.

The more specialised a divisions, the higher is the need for a common understanding of company goals and project goals. Employees from different divisions work together on different projects and interact in teams. These teams form a special kind of dynamic information network cross to typical information channels of a company. Nonaka called this type also a "hypertext organisation" (Nonaka, Takeuchi, 1995) and later an organisation as organic configuration of ba (Nonaka, Konno, 2003), because the structure is dynamically formed on demand and changes in time.

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