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Concept for a web based Support of the Product Development Process

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Abstract: During the last years there have been some developments in the internet which might support the product development process. Some ideas at the beginning of the millennium have shown that web based systems can raise the efficiency, but the possibilities are nowadays much higher. While at that time representations have been only in a static state, they can now be handled much more user-friendly and get accepted like shown with Wikipedia or Facebook. Interesting further opportunities are given by Open Innovation, where problems are solved by a big amount of online users.

This concept will show principal components of an integrated web based system, which supports the development methodological approach, reduces the workload to collect and enter redundant data, allows collaborative and partially asynchronous cooperation and will contribute to determine and map the knowledge and experience of the employees, what should lead to a higher ability to compete and gives a clear competitive advantage.

1 Introduction

The competitive pressure on enterprises of almost every sector is on a high level and will probably grow further, driven by the Emerging Markets, while the customers on the other hand are requesting a more and more specific diversity of products. The enterprises also have to face problems of losing know-how, caused i.e. by the demographic change. The resulting requirements for the Development Process with abridged time-to-market cycles, improved meeting of the customer needs and a less amount of know-how carriers are enormous.

Some enterprises already got to know the advantages of a development methodological approach. Which includes shorter development times, better design solutions by using established best-practice ones and comparison of different solution variants based on lots of ideas. Further advantages are given by less material- and manufacturing costs,

reduced needed documentation and most important at all, a higher customer satisfaction. But still most of the enterprises have a non-methodological approach or work even intuitively [Eh03] [PBF05].

First IT-supporting tools for the Development Process have been developed in the last century. While those tools often supported project management or process management, they often were not flexible enough for companies to use them efficiently or they were not supporting any methods of the development methodology. At the beginning of the millennium some projects have shown the positive effects of web supported development methodology like reduced development costs by 20% and reduced development time by 25% (projects in plant engineering, production of domestic appliances and railway vehicle manufacturing) [ESV01]. But this support assisted the user/ team member only by giving textual instructions for each process step during the development process and maybe offered standardised documents to download. Other IT-supporting tools usually addressed the product data management or CAD-systems what are different themes and should not be considered in this paper.

Nowadays, there are possibilities to compensate the mentioned disadvantages and to support the development methodology much more, by using easy extensible web technologies. Especially young employees are already familiar with those technologies and could assist older employees to overcome possible inhibitions.

The following sections will sketch an integrated web based system, starting with the basis functionalities of the total system in section 2, the basis project management functionalities in section 3, the special functionalities in section 4 and ends with the conclusion in section 5.

2 Basis Functionalities

Most of the following seven functionalities are common standard or are part of additional software in the companies which can normally be accessed via interfaces (APIs). But for showing the possible benefit, it is easier to think of an all integrated system.

For having a personal system which allows secure file access and know-how access as well as to communicate with other members and to be informed about all relevant activities the basis functionalities should include

- A Login,
  so the system can generate dynamic user and role specific views.
- User profiles,
  so other members can have an idea with whom they are working with when they see a picture of the other user.
- A Document-Management-System,
  so files can be handled by checking them out and in.
- A Wiki,

so information can be entered and accessed central.

- A Blog-system,
  which works as a collaboration-platform like a forum and can be used as well as a comment-system or for user-to-user communication as a message-system.
- An Activity stream,
  so every user gets clearly informed about what happened globally (inside of the company/ enterprise) and in the projects he is part of. It allows also the direct entry by using the links in the activity stream.
- A Versioning-system,
  so every entered data or uploaded file can be restored.

The system should be based on a server with a database, where the information are stored.

3 Basis Project Management Functionalities

After successful login the user sees the activity stream, a list of the activities or at least the count of activities that happened since his last login. Those activities are ordered and grouped by global activities, those who belong to everything out of the projects and by project specific activities, so that the user is able to get an idea how much has happened in each project (s. Figure 1).

Furthermore the user can access each project by the links of the activity stream or he can create a new project, provided he has the necessary rights.

Figure 1: Exemplary project Activity stream

Each new project can be chosen from a predefined type, like e.g. the four development phases of the VDI 2221[1] [VDI93] or the ten phases of the Value Management[2] [VDI10].

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[1] Clarify the tasks; plan; design; work out
[2] Prepare project; define project; plan project organisation; collect comprehensive data on the object; analyse functions and costs, formulate detailed targets; collect and develop solution ideas; evaluate solution ideas;

It is also possible to enter new or adapt existing project types and phases. This allows the company to build master types of their own usual development process(es). These phases will lead through the projects. Components (tools) which assist the methodological approach can be assigned to specific phases, so that it is easier to give the user a clear view of expedient tools. Using master types helps also to live a continuous improvement process.

Checklists can be developed and assigned to a total master project as also for each phase to support the project(phase). These checklists as well are derived from adoptable master copies to live the continuous improvement process.

This basis functionalities should enable a project team to do their usual work only in a different system. So the conventional way of working is still possible. The positive effects of this system can be achieved, when the components described in the next section are used. In that case, the tools can start to work together and generate an added value.

4 Special Functionalities

4.1 Data Access

The common systems already have a rights and role management. But those systems can normally only check if someone has access rights, denying restrictions cannot be handled. In [Ha12] the author points out that enterprises in the industry are interested in using Wikis, but she found out that the users are afraid of using Wikis to share confidential data, if the Wiki can be accessed by everyone. The usual solution of the enterprises ends in Wikis which can be accessed only from some departments or they renounce to use Wikis.

Another idea would be to use a rights and role management based on the mathematical theory of sets. This would make it possible to give a group of people the right to access the data and also to give other groups or persons the non-access right what reduces the set (s. Figure 2). Especially for large enterprises with lots of different user groups and therewith many roles this should simplify the administrative work, because it will not be necessary to define for each reduced set an own role.
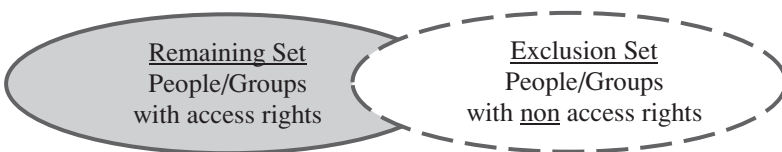

Remaining Set
People/Groups
with access rights

Exclusion Set
People/Groups
with non access rights

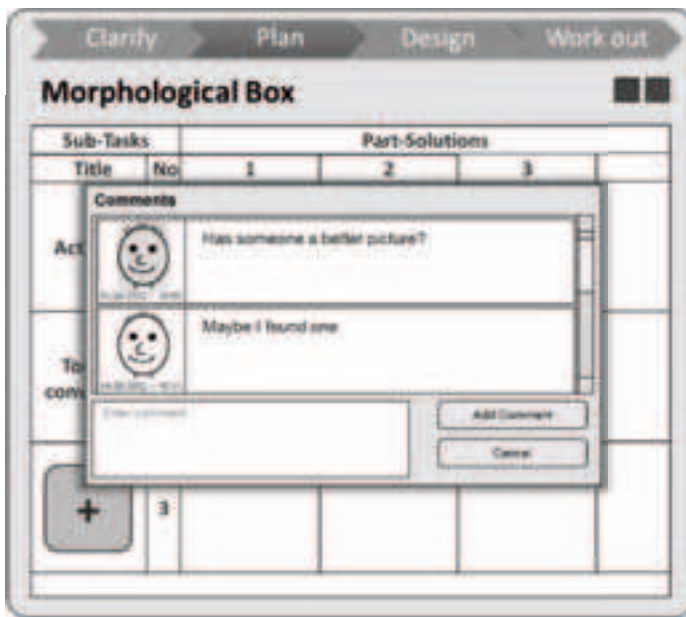Figure 2: Rights and role management based on the theory of sets

develop holistic proposals, select solutions; present proposals, bring about decisions; implement decisions, realise proposals

A possible implementation would be to allow each tool to register their necessary rights in the system. Therefor it would be helpful to register the 'dominant-right' and also the 'anti-right' and map both with each other. For each access request the system can then check which rights exist and if there is a dominant one.

4.2 Communication

For collaboration on the platform it is necessary to be able to communicate. While audio and video support is difficult to implement and also needs a lots of bandwidth, the implementation of text based communication like messages, chats or blogs is easy. As shown in section 2, the communication should take place with a blog-system. This blog-component is planned to be configurable so that it can be used for different tasks on the

Figure 3: Principle schematic of the direct blog communication

platform, e.g. as a communication user-to-user, as a real blog (like a forum) and as a chat. The blog functionality can further be implemented on its own, but also integrated in several tools like a comment-system shown in Figure 3. This enables to communicate e.g. about one entry of a Morphological Box, directly in this view and concentrates the flow of communication what accelerates the access to specific information.

4.3 Knowledge Management

Knowledge management is one of the most import things enterprises should take care of. The demographic change, with less young employees and older and older getting employees, makes it necessary to save know-how of older employees, because it is not

possible anymore to transport know-how from only one person to another one. Especially older engineers have a lot of expert knowledge and experience. It is probably not possible to prepare all knowledge in a way to make it accessible for the company. But if only some main parts of the knowledge, like concepts and ideas would be available and requirements and failure-know-how would be documented, assigned and comfortable findable, the enterprise would be much more ready to face the future.

As shown in section 3 several parts of this integrated system follow a continuous improvement process. Therefor the used elements to work with are only derived from master copies and will be updateable if the master copy has changed.

One main part of the planed knowledge management is a Wiki with a rights and role management described in sub-section 4.1 and the mentioned advantages.

As first step of the development process of the VDI 2221 [VDI93], it is necessary to clarify the task. The main result of this process is the Requirements List, which will be one tool of the system.

Another very helpful element is the Morphological Box, which is (most often) a tabular tool to collect part-solutions for sub tasks. Normally this is a big sheet of paper which is generated in some creativity meetings. By using a web based system, it is now possible to think of different ways which are similar to some aspects of the 'open innovation' idea (s. Figure 4). Exercises like splitting tasks in sub tasks as also generating part-solutions can now be done and entered from everywhere and asynchronous. So the Morphological Box can now grow and get more detailed over the time. The rights and role management mentioned above helps to secure this know-how. By linking part-solutions directly to the wiki it is possible to generate primitive first basic versions of new wiki articles automatically after entering new solutions. Also backward linking to the Morphological Box is possible and seems helpful. Another supported output are Development Catalogues, where a user can find different part-solutions for only one task. Those Catalogues have normally more detailed information so that it is easier to compare and work with the different solutions. Conventional Catalogues needed all the information on one large Sheet for quick access but webpages can present the same information more clearly on different pages. The quick access is guaranteed with links. Thinkable is also to enable the users to add columns to a catalogue. Like the Wiki article could those catalogues be generated in a first version out of the Morphological Box. A linking to the Box and also to the Wiki should exist. Also an update functionality between mapped Boxes and Catalogues would be very helpful to combine the benefit. But one main benefit would lie in the possibility of supporting the build-up process of a new Morphological Box, when word suggestions would be offered for entering the sub-tasks and part-solutions and also to offer a complete list of solutions based on already existing Boxes and Catalogues.

If the Morphological Box is filled complete enough, users can in the next step develop solution variants for the total task. For each solution they have to combine one part-solution for each sub-task by starting in the first row and ending in the last one. The

different solution variants should be then rated (s. sub-section 4.4) and analysed so that maybe some other and better variants can be developed.

Figure 4: Exemplary Morphological Box

The solutions and their ratings are further important parts of knowledge which now can be accessed from anyone and everywhere provided the required rights. If the future brings any new technologies / innovations or one user has another idea, the Morphological Box can be extended. It is then only necessary to check potential new solutions and rate them as well to actualise the information.

4.4 Decision support

Decision support means components which help to decide and to differentiate between opportunities. For differentiation of criteria of comparability the Pairwise Comparison[3] is one possibility. Because it is in this case implemented in a web based system the comparison process can also be accelerated by using the improved pairwise comparison version [Oe12], which reduces the amount of decisions to make, dramatically.

For rating different solutions the system will have a benefit analysis component. For each solution and every criterion users have to rate the solutions on a defined scale about how much them fulfil each criterion. These values multiplied with the percentage weight

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[3] Criterions to compare are listed rowwise and colwise in a table. Each row gets then compared and rated (+1 better , 0 equal, -1 worse) with the crossing column. The rowsum divided by the total sum results in a percentual weight for each criterion.

of the pairwise comparison will end in a percentage rate for each solution and allows a quantified comparison.

4.5 Creativity support

For innovative products creativity is the key. There are several different famous techniques to support the creativity like e.g. Brainstorming, Brainwriting and the Delphi-Method [Eh03]. Because it is not planned to implement audio or video supporting tools, Brainstorming is ruled out. Brainwriting however is predestined for an implementation. In the conventional way people would meet and write their ideas on small cards. The cards are then sticked up on a wall and can be afterwards grouped and extended. All of this is usually organised by a moderator.

For supporting the creativity, the planned tool works similar to a chat-system. Ideas can be entered and will be seen of every logged in Member directly in the chat-box. One main difference is that it is not visible who and when an idea was posted, what should increase the willingness to post own ideas.

Also one person should fulfil the moderating part. This person is able to post comments like "We need more." or "What would it be if you describe it in a negated way?". Those comments should be saved in the database as well, so that the comments can be entered and posted directly or be chosen from a list of existing comments. Another idea in this topic is to automate this process. After the Brainwriting session is started, the server could measure how many ideas are posted in which distance of time. If the distance hits a threshold value, a comment could be automatically, randomly selected and posted to push the creativity again.

The moderator also ends the first creativity part. Afterwards the users are enabled to group the ideas and to give them meaningful names/titles. If necessary the moderator can start another round to extend the amount of ideas.

The described Brainwriting tool works synchronously. It is also conceivable to use the same tool in an asynchronous way. Therefor it should be configurable so that the component supports both ways. The asynchronous part would probably make a moderator needless, so functions like grouping and renaming should be accessible right from the session start. For an asynchronous Brainwriting a maybe helpful property would be to define a time stop when the session ends automatically like e.g. 'in four days'.

For both ways it is possible to use the idea of 'open innovation', so that not only the project team is invited but also maybe the total enterprise[4].

The possibility of using this data directly in other components like e.g. the Morphological Box should be clear.

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[4] Open Innovation means normally a free access also from outside of the company. Most Enterprises of Mechanical Engineering are normally very suspicious and conservative so that an 'inhouse open innovation' variant might be more accepted.

Later on, the Delphi-method could be implemented as well. Possible is to think of inviting (extern) experts temporary to such a creativity session with very less rights. The standard procedure of a Delphi session is to ask experts for specific solutions, to review them and to deliver the reviewed solutions afterwards to all of them again, to get a better expertise. An implementation should be very easy.

4.6 CE – Compliance support

With the CE declaration of conformity every enterprise guarantees the conformity with all necessary regulations and laws. It is obliged to put the CE mark on products that are sold inside the European Union. An FMEA (Failure Mode and Effect Analysis) helps to fulfil here for necessary requirements.

To support also this step it is planned to implement a component which lets the users accomplish an FMEA inside the web system. It works also in a master copy way like described before so that further problems or difficulties are collected centrally.

FMEAs are tabular views that include for each possible failure / problem / difficulty a description of the problem, a description how to handle it, three values on a scale from 1 to 9 for the probability of occurrence, the probability of detection and the value of importance and the risk priority value which is the mathematical product of those three values.

The FMEA component should also have an integrated blog system. Comments would maybe help, but blogs for improvement ideas, mapped directly to one FMEA or even one entry, analogue to the requirements list, could accelerate the improvement process much more.

5 Conclusion

The presented system includes a project management functionality extended with key elements of the methodological approach. These elements allow the reuse of data e.g. entered in a Requirements List in a Pairwise Comparison and afterwards the extended data in a benefit analysis to enable decisions based on quantified values. Entries in Morphological Boxes are mapped to Development Catalogues and to a Wiki and can be extended from everywhere and anytime what should push the amount of, and know-how about, different possible solutions.

The different right and role management guarantees an easy administration, where every user can control the data access for data he is authorised to. This enables the total enterprise to participate of ideas made somewhere else but also allows to keep information secure.

The channelled and mapped comments in blogs enable the users to access information where they belong, what should accelerate the access and enables the enterprise later to analyse and improve their development process. The Activity stream further guarantees