Knowledge creating Communities in the Context of Work Processes

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ABSTRACT
This article deals with the support potential of knowledge communities for a co-operative knowledge generation and problem solving before the background of the increasing economic importance of knowledge-intensive processes. Therefore, requirements for an IT-support of a co-operative knowledge generation and problem solving via knowledge communities are being developed that are of significance in the induction and dissemination of knowledge within communities. Special emphasis is put on the integration of the knowledge of the community into relevant work processes aiming at an initiation of synergies with this combination. According to the above-mentioned requirements, we will present the realisation of a knowledge community with the help of the Wiki-approach. Thereupon, a concept for integrating knowledge communities in process-oriented knowledge structures will be developed by creating an adequate interface. This concept could be realised in a prototype way in an implementation. The developed prototype will be described in a brief case study.

Categories and Subject Descriptors
H.5.3 [**Group and Organisation Interfaces**]: *Collaborative computing, Asynchronous interaction, Computer-supported cooperative work, Theory and models, Web-based interaction*

General Terms
Documentation, Design, Human Factors, Theory

Keywords
Co-operative knowledge generation, knowledge communities, knowledge-intensive processes, work processes, knowledge processes, process-oriented knowledge structures, Wiki

1. INTRODUCTION
Tasks in work processes are increasingly complex and knowledge-intensive. In coming to terms with these tasks, often situations occur when the knowledge on hand is not sufficient for finding a solution, at least for the person concerned. Such cases require, on one hand side, ad hoc acquisition or redevelopment of knowledge. On the other hand, this must be done in co-operation with other people. Presently available IT solutions of the knowledge management are deficient in this case as they only supply available, already expatiated knowledge, for instance in form of documents or along inflexible knowledge structures (ontology). Contrary to this, communities support communication which is fundamental for the exchange of knowledge and experience thus promoting processes of co-operative generation of knowledge and problem solving. Disadvantageous features of knowledge generated and expatiated in communities (community-made knowledge) are its chaotic structure, enormous size and a speedy growth leading to complexity. A technical support for communities is thus put before the challenge to enable a context-related access to the expatiated knowledge of the community. This article intends to present a concept for communities to support a co-operative generation of knowledge in knowledge-intensive work processes and a tool based on this concept. The core of the idea is to integrate communities with process-oriented knowledge structures. A community support was designed that refers to work sequences as context and orients on the inherent tasks and problems. Technology thus supports a context-based access to the community's knowledge as well as a flexible generation and preservation of new knowledge and experiences along knowledge structures of the community. The weak points of community applications, i.e. the missing context-related access to the newly developed knowledge, as well as of knowledge management systems, i.e. an inflexibility concerning a co-operative generation of knowledge, can be mastered.

In the lines below, essential characteristics of knowledge-intensive work processes are analysed. In addition to that, requirements for an IT support of a co-operative generation of knowledge are deduced. The Wiki-concept will be presented as an appropriate approach for meeting these requirements. A concept for integrating knowledge communities into process-oriented knowledge structures will then be developed. Therefore, an interface facilitating a process- and thus context-specific view of the knowledge was designed. With the help of this, synergies from combining knowledge communities and process-oriented knowledge structures were created. The concept developed here was realised in a prototype way.

2. Co-operative Knowledge Generation in knowledge-intensive Work Processes
In the paragraph below, essential features of knowledge-intensive work processes will be brought forward. On the basis of these features, requirements of an IT support will be deduced subsequently. In conclusion, the Wiki-approach will be presented as a form of community support that meets the set up requirements.

2.1 Features of knowledge-intensive Work Processes
Tasks in work processes are increasingly knowledge-intensive and require competent employees as well as knowledge and experience which have already been gathered in different areas of a company.

The density of knowledge of work processes requires not only the practice of existing knowledge but also, and most importantly, the generation of new knowledge. In coping with knowledge-intensive tasks, problems occur that require more than the knowledge on hand but knowledge that must be created and utilised *in* the process. Knowledge-intensive processes can accordingly be understood as both work and learning processes.

Furthermore, increasingly complex and holistic tasks have lead to a situation where a co-operative generation of knowledge is inevitable. In practice, the necessary knowledge may be carried by different experts, or a co-operative generation of knowledge may appear more efficient than an individual one.

The process of generating knowledge always has a social component. Knowledge is generated by putting information in a social context. This way, information can be interpreted differently for varying contexts with varying meanings. For managing a mutual understanding and consensus in the context of problem solving, constant feedback between the carriers of knowledge is significant.[1]
Another feature of knowledge-intensive processes is the fact that they cannot be planned a priori and thus cannot be put into algorithms and formalised in an end-to-end way from the start. They contain tasks necessitating knowledge that must be creatively developed and applied in the process. Coming to terms with these tasks, new tasks emerge in the run of the process that cannot be anticipated beforehand. This means that the structure of such knowledge-intensive processes cannot be deduced mechanistically or set from the start but must be compiled *in* the process.

A high degree of autonomy of the employees as well as a large leeway was observed due to partially indeterminate or incomplete tasks, numerous variants and special cases. Furthermore, these processes are commonly conducted by creative employees who show a high degree of independence and innovation. Control over the co-operative work process is entirely in the hands of the co-operating people. Thus, they can self-determinately choose the necessary co-operation partners, tools of communication and knowledge carriers and determine operations and functions before and in the run of an operation [1].

2.2 Requirements of an IT Support for co-operative Generation of Knowledge

Providing and generating knowledge are decisive for coping with knowledge-intensive work processes. Technologies of knowledge management must therefore be linked with tools supporting co-operative work.

2.2.1 Process-oriented Supply of Knowledge

Knowledge required for coping with real-life tasks in the work process is often available in IT-systems, e.g. codified within It-systems, documents, or community applications. This company-inherent knowledge must be made transparent and accessible according to a collectively accepted knowledge structure referring to the work process. Process-structures are particularly fit here, as they facilitate references between a person's individual work process and the available knowledge carriers (i.e. people, documents etc.). The knowledge carriers relevant for work processes and single activities can therefore be tracked utilised and implemented more easily which alleviates the integration of knowledge carriers into the context of work. A process-step like „determining requirements" can retrieve all the required catalogues of projects. This result would usually have necessitated the selection of every single project. Such a structured supply of knowledge can be supported by the technologies and tools of knowledge management. The APO-Pilot [2] (see chapter 3.1) is an example for a tool like this.

2.2.2 Co-operative Knowledge Generation

A conjoined production of knowledge requires the support of the co-operation of a number of people:

- Individual knowledge must be made accessible for the community. Particularly implicit knowledge must be retrieved and made explicit. Knowledge by experience must be recorded.
- The individual must associate the external (individual) information with the collective knowledge basis of the community. Therefore, he/she must be given the opportunity to utilise the entire knowledge base as well as to make personal associations with it.
- Collective evaluation and interpretation of external information: all community members must be enabled to participate in the evaluation and interpretation (focus on the collaborative process of generating knowledge).
- Integrating and re-structuring the collective knowledge base (focus on the collaborative result of generating knowledge).

Thus, a shared, networked and evaluated information inventory is brought into being which then serves as point of reference for the co-operative further development of the shared knowledge base.

Furthermore, the difficulty of motivating knowledge dissemination plays an important role. The possibilities of making knowledge explicit must be of a nature that have an individual share and formulate his implicit knowledge out of personal interest [3]. In the context of developing support for a co-operative knowledge generation, the following should be considered:

- The process of making knowledge external takes place within the individual and therefore cannot be item of an IT-support. Formulating explicit-made knowledge, embedding it in a context and filing it in an adequate system can well be supported. This requires the construction of a tool that permits the operation of knowledge supply and dissemination at minimum costs for keeping the subjective expenses of this activity as low as possible.
- If an individual can benefit actively and consciously from the knowledge of other people in the work process, the awareness of personal responsibility for the maintenance of the collective knowledge base increases. Even after finishing a task, the respective person has the wish for subsequent units to provide equally high-quality and extensive knowledge. This fact changes the personal perception regarding knowledge backflow as a means of broadening the present knowledge base.
- Putting personal knowledge components directly and visibly into a context with other knowledge components creates a feeling of a strong companionship which then can work as a powerful motivation for disseminating knowledge. According to the theory of „Situated Learn-

ing“ by Lave und Wenger [4], the reason for learning must be found in the participation in communities (Community of Practice). Participation and learning are seen as a means of becoming a full-fledged member of this community. The altered effect of a person on his/her community because of his/her gain of knowledge is, according to the theory, the motivation for learning and disseminating knowledge [5].

Summing-up, it can be said that for a co-operative generation of knowledge (in consideration of the network character of co-operatively generated knowledge) a tool must be utilised that facilitates an *adding* and *editing* of content besides the *supply* of existing content and a networking of these contents (hypertext) by a number of spatiotemporally distributed users. Moreover, it must be equipped with a *minimum of functions* requiring *very little learning* effort regarding its operation. Finally, it must enable *free and simple referencing* with other knowledge components.

Solutions for the Computer Support of co-operative Work (CSCW) – particularly Community-Support-Systeme – support co-operative work processes and processes of generating knowledge [6]. A Community-Support approach meeting the requirements is the Wiki-concept that will be introduced in part 2.3.

2.2.3 Linking Knowledge Management and co-operative Work

The support of knowledge-intensive work processes urgently requires the availability of integrated solutions (from knowledge management and co-operative work) [7]. These must enable a continuing further development of supplied knowledge in a co-operative process. Therefore, a tool meeting the following additional requirements must be created:

- Context-related (process-oriented) access to the knowledge network resp. knowledge of the community. The individual situation, i.e. the actually worked on sub-process or task provides the context on the basis of which available information is interpreted. This context in turn can be used to enable the creation of a process-specific perspective of the knowledge network. This serves to determine the context-specific relevance of the individual components of the network.
- Co-operative generation and preservation of knowledge in the community without a constriction of the social, self-organised knowledge regeneration process of the community by given process-structures. This basically means an extension of the community knowledge can also be operated in a process-spanning way, making an (unequivocal) allocation to individual process-steps unnecessary.
- A possibility to (loosely) associate knowledge components. The process-spanning construction of the knowledge network leads to a situation where the relevance of network components that are not directly linked with a process-step does not automatically become clear. This missing reference to the work process (context) may lead to a diffuse structure disabling the user to orient and find his way in the knowledge network. Thus, the context (i.e. reference to the individual operations in the work process) of any component in the network must be retraceable

The above-mentioned integration requirements are met by a prototype that will be introduced in chapter 3.

2.3 Community-Support for co-operative Knowledge Generation – the Wiki-Approach

In the following part, the Wiki-approach will be introduced as an appropriate community-solution for meeting the requirements for an IT-support of a co-operative generation of knowledge.

A WikiWiKiWeb or "Wiki"[1] for short is an open author system for a conjoined construction and maintenance of websites. Links to further Wiki-sites and information can be gathered and filed here. Wiki-software offers a fast and simple way to draft and edit websites online. This means that all the Wiki pages can be commented, edited, added and even deleted by all users. New pages can be drafted easily and linked with existing pages. A Wikiweb is characterised by a simple interaction and easy-to-use navigation on the sites. The boundaries between the (active) author and the (passive) user of contents are removed. In a short time, this leads to a huge „chaotic“ building of networked Wiki-sites (knowledge network).

Wikis have a very low utility threshold due to their flexible structure and a realisation of the easiest possible way of use [8]. The possibility of central access for all the users or limited user groups makes the Wikiweb an ideal choice when it comes to running projects, drafting documentations, a conjoinedly production of concepts or discussion boards. This is a technology for building up online-communities and co-operation and communication platforms. Regarding knowledge management, the Wikiweb particularly offers a potential of knowledge development. The provided knowledge can be modified and extended on the spot and thus gives rise to an integrated, interdisciplinary and co-operative knowledge base.

Considering the particular features, a Wiki may be applicable in many different scenarios: as content management system, discussion board or other forms of group-ware support. With the help of a Wiki, newly acquired knowledge can be easily gathered and integrated into a context with the present (Wiki) knowledge base by the user. The particular advantage of the Wiki-approach in comparison to other ways of co-operative knowledge generation and exchange is the focus on the *process* as well as the *result* of communication.

Content and document management systems focus on the exchange of results of a co-operation. Processes of communication and discussions leading to or extending a result, i.e. the document, are limited to annotations on or in documents for example. Discussion boards focus predominantly on the process of co-operation of the participants. Thus, opinions can be exchanged creating a common sense. The result of the discussion is mostly contained implicitly in the corresponding contributions and must be extracted and condensed afterwards. In comparison to that, Wiki’s permit discussion *and* simultaneous work on the conjoined result.

[1] The Software „WikiWikiWeb“ was developed by Ward Cunningham in 1995. An overview of currently available implementations can be found in [12].

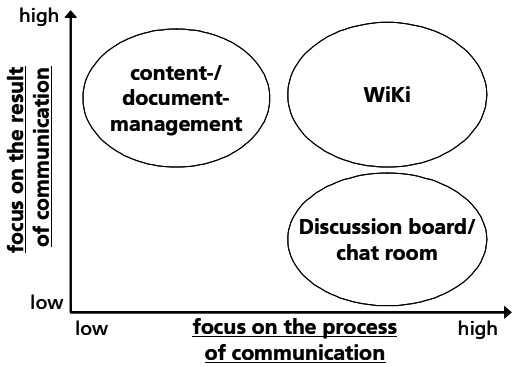

Figure 1: Communication-oriented classification

The afore-mentioned requirements for a tool supporting a co-operative generation of knowledge are widely complied with by the characteristics of a Wiki. Moreover, a co-operative production of content is realised very efficiently by removing the distinction between author and reader resp. knowing and learning person.

The major importance of a conscious and active benefit of other people's knowledge has already been dealt with in the beginning. In addition to that, building up a strong companionship with the help of the establishment of Communities of Practice was called for. Again, the Wiki can meet these requirements by creating a feeling of co-operation with other experts due to the immediate visibility of the members' individual participation and the removal of a superior controlling authority.

3. Prototype Realisation

In this chapter, we will introduce a tool meeting and implementing all the requirements, especially the integration of knowledge networks into process-oriented knowledge structures. Therefore, an interface facilitating process- and thus context-specific views on the knowledge network was drafted and implemented. This integration concept is founded on the idea of including the process structure in the development of the knowledge network as a design criterion rather than detaching it. An important clue about the information supply extracted from the network is the assumption that the user is situated within a familiar process when knowledge gaps occur. Involving the individual situation of the user creates the context in which he/she interprets the supplied information. This context can in turn be used for setting up a process-specific perspective of the knowledge network permitting a context-specific rating of the network components. On one side, this supports the community in the process of co-operative problem solving. On the other, it supports the documentation of the solution, i.e. the result of the process.

This implementation consists of 3 independent components. First, the APO-Pilot functions as a process-oriented, global knowledge base. Second, the PmWiki will serve as the Community-Support-System supporting the process of co-operative generation of knowledge. In addition to that, an interface according to the above-mentioned concept was implemented between the APO-Pilot and PmWiki. At first, we will shortly introduce the APO-Pilot and the PmWiki. The implemented interface will be presented in greater detail subsequently.

3.1 Process-oriented knowledge Base– APO-Pilot

Working in knowledge-intensive work processes necessitates a tying of knowledge to the activities in the work processes. With the APO-Pilot, a tool accompanying the work processes was implemented that consistently follows the aspect of process-orientation. The APO-Pilot supports the process of generating knowledge in the work process and facilitates the flowback of new knowledge acquired by applying available resources, reflecting the work process, and making practical experiences.

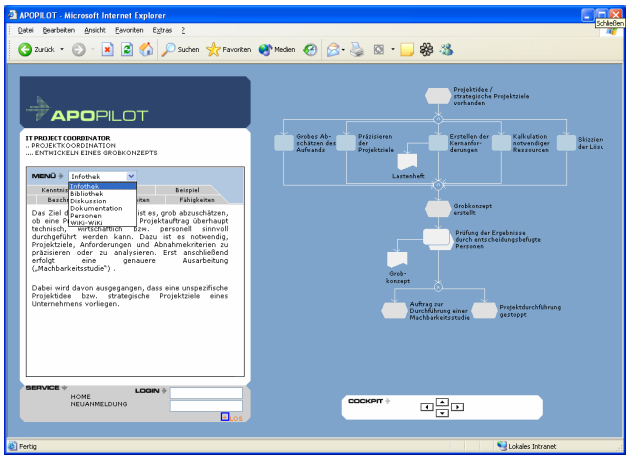

Figure 2: APO-Pilot

The APO-Pilot facilitates a process-oriented navigation through the modelled work processes of a company. Working as an assistant without an active control, it visualises the run of the process in form of IPC's (incident-process-chains, Germ.: EPKs) and supports the structuring of the work process. Besides the supply of knowledge supporting the run of the process, every process, process-step and activity is provided with different knowledge carriers helping the employee cope with his task. These sources of knowledge, commonly distributed in different IT systems and independent from work processes are now integrated and structured in a uniform, process-oriented view. Every process-step and every operation will be provided with documents or other adequate materials (e.g. from the intranet; domain Library). People appropriate as competence carriers (experts etc.) are suggested with on-hand means at communication (mail, telephone, video etc.) in the domain People. In the discussion domain, discussion boards are supplied for exchanging experiences, perspectives and options as well trouble shooting.

In addition to that, an access to a Wiki will also be supplied for a process-spanning support of a co-operative generation of knowledge.

3.2 Co-operative Generation of Knowledge – PmWiki

In realisation of the Wiki for the APO-Pilot, the PmWiki by Patrick R. Michaud [9] was utilised. The PmWiki is a small Wiki developed in PHP necessitating adaptations regarding content and layout. The reasons for choosing the PmWiki are the usability of the software based on GNU Public License and the simple adaptability because of PHP- implementation.

Moreover, the PmWiki shows a number of unusual features (concerning Wikis) that turn out to be rather useful in combination with the APO-Pilot. Among these is the possibility to pool document and provide them with a right of access. Another important feature of the PmWiki is its assumed continual further development creating stable grounds for a future development of the prototype introduced here.

3.3 Function of the Interface

The APO-Pilot, as an example for a knowledge base structured by processes, supplies every process-step or activity with a (process- or activity-related) access to the Wiki as the community's knowledge network. Starting from the current process, in this case „developing a concept outline", the corresponding Wiki-site can be immediately addressed or else, the entire Wiki may be searched for a specific term (e.g. „to do list", see figure 3).

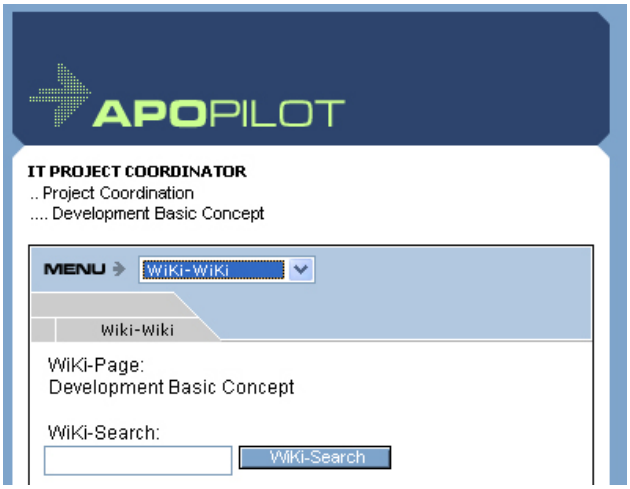

Figure 3: Access-site of the Wiki

The direct call of the Wiki leads to the call of the correlating process-specific interface-document in a separate browser window. This Wiki-site can thus be edited, new sites can be created, or the Wiki can be „navigated" through (see figure 4).

Figure 4: Interface-site

Looking for a search key, all the sites of the Wiki are searched. With the help of distance classes and distance class-depending frequency of reference of the chosen process-step, the hits will be screened, evaluated and presented according to their process-specific relevance (see figure 5).

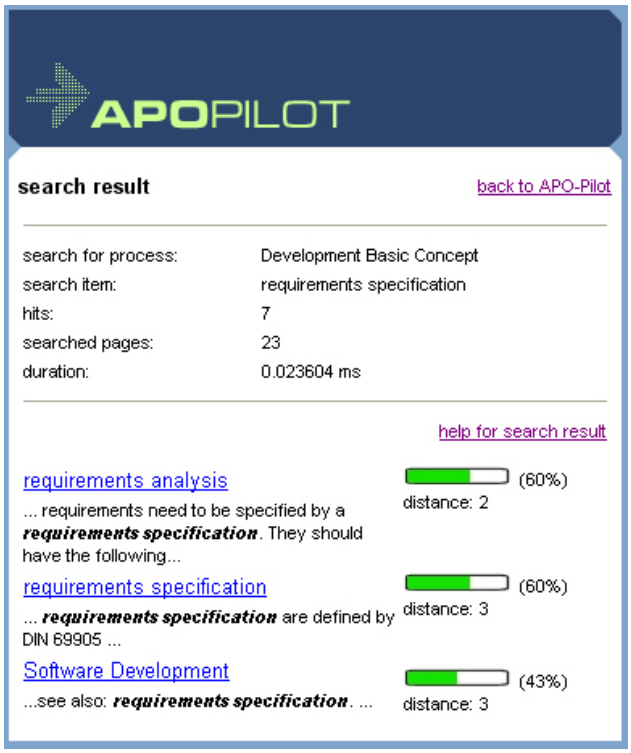

Figure 5: Process-related result

Beside the relevance, graphically expressed by a green bar as well as in percentage, the result also contains features of the correlating distance class („distance"). Furthermore, the name of the site and the context of the search key are presented. Clicking the name of the site, the Wiki is opened in the corresponding place. The head of the site shows general information on the result of the query, particularly the process the query was conducted for. This piece of information is important since a query with the same search key for another process would have lead to a completely different result. In addition to that, a tool helping to explain the query result can be called.

The return to the APO-Pilot is possible from every Wiki-site. If the current site is an interface-site, the corresponding process-step will be opened in the APO-Pilot. In case of finding no matching site, all those process-steps with the shortest referential distance compared to the chosen Wiki-site are determined. Simultaneously, the user is provided with a facility to return to the APO-Pilot (see figure 6).

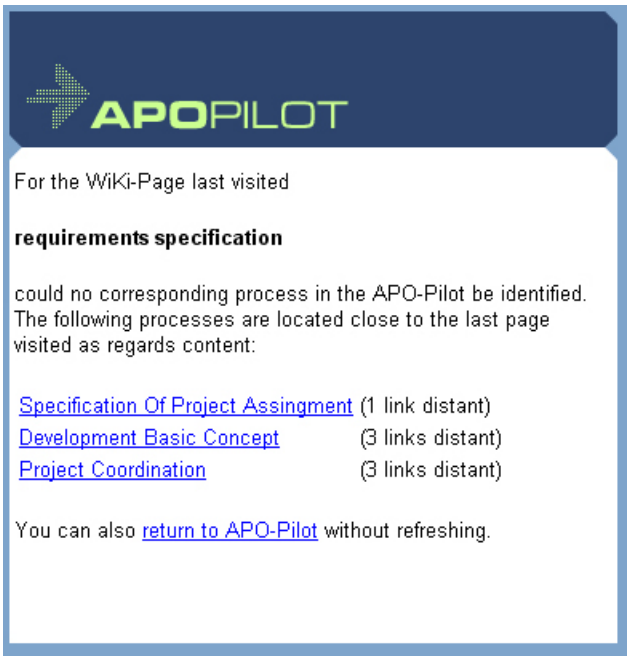

Figure 6: Return to the process model

4. Summary

Knowledge-intensive processes are characterised predominantly by problems that cannot be anticipated, containing beside a process-related supply of available sources of knowledge also processes of co-operative problem solving. Due to a high complexity of problems, co-operative problem solving necessitates a process-spanning exchange of knowledge. It became clear that knowledge networks can highly contribute to increasing the intrinsic motivation for disseminating knowledge by creating a platform for Communities of Practice. The Wiki-approach was introduced as a technological means of realising a network like this. With the help of the Wiki, the classical roles „author“ and „recipient“ are removed. Creating synergies in combining knowledge networks and process-oriented knowledge structures was shown by the prototype. With the prototype implementation of a Wiki in the APO-Pilot, we managed to develop a tool for a co-operative generation of knowledge while considering the afore-mentioned requirements. The particularly low utility threshold due to the easy and intuitive usability of the Wiki as well as the improvement of the information retrieval process in the knowledge network by using process-structures serve as examples for that.

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