Building a Community of Practice in Product Development

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Abstract: Product Development is essentially a knowledge creation process. Thus, one factor for the successful leverage of this process is knowledge sharing and an important way to perform this is by creating communities of practice to improve knowledge. This paper aims to present the creation of a community of practice in product development, emphasizing the collaboration process and knowledge sharing initiatives among research groups. This experience is based on a real community in Brazil that initially was composed of many product development. research groups. The community of practice, called PDPNet (Product Development Process Network), uses a knowledge management portal to facilitate member interaction, knowledge sharing and exchange for the generation of new knowledge. The paper presents some possibilities for the use of this tool in order to improve collaborative product development and the relationships involved.
Keywords: product development, communities of practice, knowledge management, knowledge sharing

1. Introduction

The importance of the product development process has been emphasized by many authors, mainly due to the significant impact on costs, quality, client satisfaction and, consequently, the company's competitive advantage. However, there are difficulties in its management since it is a dynamic process, essentially creative, dependent on the abilities and knowledge of the people involved. It is also an interdisciplinary process, which involves people from different areas of the organization and from client, associate and supplier companies, for which the experience is an extremely important factor.

Considering these characteristics, it can be seen that the sharing of information and learning, are fundamental for this business process. An environment where experienced professionals transmit their best practices, where problems are best discussed, where new findings are reported immediately and where people are involved in a continuous process of learning, must be guaranteed. The result will be better prepared and updated people, guaranteeing a better performance in product development.

One of the ways to create this environment is through communities of practice (WENGER et al., 2002). According to the authors, communities of practice can be represented by a group of people who share common interests and who unite in order to create new knowledge, starting with the community of practice and around a specific theme. Within a company various communities of practice which would assist the product development could be created.

Although it is not a new concept, communities of practice have recently taken on special importance. Organizations are now aiming to encourage their creation and to give them a more central role. One explanation for this change is the perception that "knowledge is an act of participation" and that knowledge must be managed by those who produce and utilize it on a daily basis. Such communities can potentialize the practices and results of the knowledge management initiatives (TERRA and GORDON, 2002).

The objective of this paper is to describe the process for the creation of a community of practice for product development, to promote the sharing and exchange of knowledge, highlighting some results and also the use of a portal as a facilitator of these initiatives.

2. The Product Development Process and Knowledge.

Understanding and defining product development involves the same difficulty inherent in questions related to the study of organizations, that is, understanding the complexity of the organizational system, it could be understood as a system composed of a group of functions, people and machines with intense and varied relations among them (AMARAL, 2002).

The process of product development makes intensive use of knowledge and much of this knowledge originates from the experiences gained in previous designs. This experience combined with new techniques and technologies can result in new ideas and designs, facilitating the maintenance of a competitive advantage. However, to reutilize this knowledge is a challenge for companies as the rhythm of changes in the market is ever more accelerated, the technologies have proliferated, the competitors have multiplied and products have become rapidly obsolete (NONAKA and TAKEUCHI, 1995).

Furthermore, in relation to the rhythm of the market, there is the fact that the needs of the clients can evolve substantially during the product development process. Therefore, two great challenges face the companies: they need to continue to learn during the development and need to incorporate new information into the product design, up to its placement in the market (MUNDIN, 2001).

Further challenges are presented when the product development process is collaborative, involving the difficulties of integration of the teams, which most of the time are formed by people in different areas of a company and with different backgrounds. These difficulties increase when there is a need for communication and integration with design teams from other companies, which could also be accentuated when these teams are geographically distributed.

In order to overcome such challenges, various theories and technologies have been created aiming to improve the product development process. One alternative is to recognize the need to stimulate appropriate values for the innovation and sharing of knowledge. One study, carried out with 600 directors and managers of 400 medium and large companies which operate in Brazil, concluded that a focus on the acquisition, sharing and creation of new knowledge increases the chances to improve business performance (TERRA, 2002). That is, successful companies have been characterized by the ability to create new knowledge, spread it and incorporate it into new products and services.

3. Management of knowledge in the product development process

The management of knowledge can be understood as a process of transformation and sharing of knowledge from the individual to the organizational level, that is, making the knowledge available to the whole organization, facilitating the solution of problems and creation of new knowledge (DAVENPORT and PRUSAK, 1998). The distinction proposed by NONAKA and TAKEUCHI (1995) permits the practical approach, differentiating knowledge into two types.

♦ **Explicit knowledge**: knowledge incapable of being verbalized. Therefore, it is an objective part of knowledge, that can be transported, stored and shared in documents, in systems, etc.

♦ **Implicit knowledge**: knowledge inherent to people, that is, the abilities and experiences which they posses. It is, therefore, a non-structured part of knowledge, which is not easily registered and/or transmitted to another person.

Organizations have innumerous initiatives that can be used for the creation and appropriation of knowledge. For example: training, design teams, improvement groups, trainee programs supervised by mentors, reports and publications, Intranet, corporate universities etc. This doesn't mean to say that there is effective management and the generation of new knowledge since these initiatives are isolated and are under the responsibility of different sectors, each one with its own objectives (BAUER and MACEDO, 2000).

The product development process can benefit from the management of either explicit or implicit knowledge, as it has part of its knowledge stored in the form of documents (reports, drawings, test results, meeting minutes, books, etc.) and information (website addresses, contacts, supplier company names, etc.) which can easily be shared – explicit knowledge – by various people linked to this process by way of information technology (AMARAL, 2002).

Furthermore, a significant part of its activities has an essentially creative character – implicit knowledge – and depends fundamentally on the involved people's knowledge, acquired through the situations experienced, decisions made, whose results may have been innovative and others even mistaken, but in most cases they are not easily transmitted to other people. Moreover, productivity in this process depends on the use of techniques and methods in constant evolution and has experience as a decisive factor for the success of its application, from the application of techniques and methods for specific activities for design detailing, passing through the utilization of tools and methodologies of general character (such as group work techniques, portfolio analysis) up to the accumulated knowledge on faults and achievements which occurred during the development of products already launched in the market (AMARAL, SILVA and ROZENFELD, 2000).

Thus, the management of knowledge must permit that the experiences of each product developed, are spread within the organization, along with all documentation produced, facilitating the continual improvement of the product development process (MUNDIM, 2001). In order to give support to the knowledge management it is possible to count on the aid of information technology to assist in the sharing and on the communities of practice for the interaction among those involved/interested in this process.

4. Information Technology for knowledge management

Knowledge management can be aided by computational tools, which facilitate the sharing, storage, imparting and recovering of knowledge. These tools were studied by CARVALHO and FERREIRA (2000) and classified into eight categories which are: Tools based on Intranet, Electronic Management of Documents, Groupware, Workflow, Systems for the Construction of Intelligent Knowledge Bases, Business Intelligence (BI), Knowledge Maps, Support Tools for Innovation.

Among the various information technology tools available, the corporate portals of knowledge have been gaining great attention in the literature of the area and also in the commercial environment of tools for knowledge management. According to TERRA & GORDON (2002) these are tools based on the internet, which deal with the integration of data sources, software applications, allow personalization, taxonomies, search mechanisms, integrate collaboration tools and systems of content management, all in a single platform.

Portals are rapidly becoming an essential tool for competitive advantage as they allow knowledge sharing, along with management and storage, publication and personalization of information. They also permit the rapid identification of people and better practices for processes and activities, ever more necessary to reach the strategic objectives of an organization (TERRA and GORDON, 2002).

It is also important to highlight that the implementation of corporate portals also includes functions to support the creation of communities of practice within the organizations, as described below.

5. Community of practice in the product development process

Communities of practice presuppose three basic elements, highlighted as follows (WENGER et al., 2002):

♦ **Domain**: subject which the community deals with, shares and creates knowledge.

♦ **Community**: people who interact and create relationships among themselves, around the domain.

♦ **Practice**: action developed by the community, in which the members learn together how to ask, and deal with, questions in which they are interested.

Communities of practice are beneficial to organizations, as they enable the generation of knowledge, creating, simultaneously, informal communication channels among the various departments or even with other organizations, since these communities do not necessarily need to restricted themselves to members of the organization. It is essential that there is effective exchange for the creation of new knowledge for there to be a community of practice, thus, an internet page, or even people who perform similar functions, but do not exchange knowledge among themselves, cannot constitute a community (WENGER et al., 2002).

The responsibilities for the informal dynamics of networks of people are attributed to the communities of practice, and according to BAUER and MACEDO (2000), the transposition of the conventional barriers of organizations is also attributed to communities configuring them as an important organizational innovation. As motivation and articulation mechanisms, the organization structure, the systems and operational procedures, stories, myths, legends and parables regarding events or people, along with definitions relating to the philosophy of organization, are highlighted (TERRA and GORDON, 2002).

Regarding the context of the product development process it can be seen that communities of practice can be of great importance due to the creative character of this process and the necessity for innovations for the competitive advantage of organizations. The possibility of a more intense exchange of experiences between technicians and engineers, the facility and agility to find solutions and the facility of up dating and improvement of the work standards, are examples. This may occur in different fields, experiences related to the utilization of tools, methods, techniques, necessary activities and also more intuitive practices developed from the practical experience accumulated by a designer or any other member involved in this process (MOSCONI et al., 2002; AMARAL, 2002).

In the area of product development teaching and research, the participation in a community of practice can also be beneficial, as the members can share their research experiences and results, promoting a single language, and also minimizing partial views still existing in this context. In particular, there follows the creation of, and activities for, knowledge management in a community of practice in product development, created and supervised with a basis in these premises MOSCONI et al., 2002.

6. Methodology

This is an action research study, which embraces a set of frequent actions by the researcher in relation to the object under study. The research action is recommended when dealing with new subjects and knowledge and when the researcher has to explore and to create knowledge related to practical aspects. The researchers of the study object being analyzed and representative participants are involved in a cooperative and participative work. The following activities were carried out:

♦ Establishment of a community of interest in product development;

♦ Transformation of the community of interest into a community of practice;

♦ Implementation and customization of a knowledge management portal for the community in order to stimulate sharing of knowledge on product development;

♦ Dissemination of the portal inside the community of practice and training of its members;

♦ Definition of the activities and initiatives to promote cooperation in the community of practice, for example: glossary creation, reference model definition, and encouraging the members to share the references they have collected on product development, such as: papers, reports, best practices, cases, sites, products, systems, methods, academic publications, etc.

♦ Following up of the activities of the community of practice;

♦ Evaluation of the collaboration impact on new knowledge and abilities improvement, using interview tools with all community members.

♦ Discussion of the proposal for the application of this experience to other contexts involving people and activities in product development.

7. Creating a community of practice in product development

Around two years ago, in mid-2001, an effort aiming to take advantage of the potential of the communities of practice, in order to improve research in the area of product development and the university-company relationship, was initiated. The purpose of this community is to allow the sharing of knowledge between researchers and professionals of national companies. Initially, it was denominated by Rede de Conhecimentos em Desenvolvimento de Produtos – Network of Knowledge on Product Development, and following suggestions from the initial participants, it became known as PDPNet (Product Development Process Network). In order to initiate it various activities were carried out to promote approximation and the joint creation of knowledge, which are described below.

7.1. General description of the PDPNet community of practice

The PDPNet community of practice was created with the support of three important research groups which work in the area of research on Management and Methodologies for Production Development, these being:

♦ **Grupo EI** – Grupo de Engenharia Integrada do Núcleo de Manufatura Avançada (NUMA) – (*Integrated Engineering Group of the Nucleus of Advanced Manufacturing*) of Escola de Engenharia de São Carlos – (*São Carlos Engineering School*) – of Universidade de São Paulo (EESC / USP) – (*University of São Paulo*), http://www.numa.org.br/eip

♦ **GEPEQ** – Grupo de Estudo e Pesquisa para o Aperfeiçoamento da Qualidade, – (*Study and Research Group for Quality Improvement*) of Departamento de Engenharia de Produção (DEP) – (*Production Engineering Department*) of Universidade Federal de São Carlos (UFSCar) – (*Federal University of São Carlos*).

♦ http://www.dep.ufscar.br/gepeq

♦ **NeDIP** – Núcleo de Desenvolvimento Integrado de Produtos – (*Nucleus of Integrated Product Development*), of Departamento de Engenharia Mecânica (EMC) – (*Mechanical Engineering Department*) of Universidade Federal de Santa Catarina (UFSC) – (*Federal University of Santa Catarina*), http://www.nedip.ufsc.br

On of the first actions for the creation of the community was the implementation of a tool to support the sharing of knowledge, resulting from a doctoral study carried out within one of the research groups (AMARAL, 2002). This environment can be considered a knowledge portal, TERRA (2002), as it has the characteristics considered fundamental in this type of tool: it allows the personalization of the interface, creation of taxonomies (classification), search mechanisms, integration of data sources, software applications, collaboration tools and content management systems. Given below are the knowledge portal, its characteristics and principal functions. In the following item, the activities of some results of the community interaction, either by means of the portal or from the initiatives and activities developed, are presented.

7.2. Implementation of a portal for knowledge management into the PDPNet community.

This was implemented as sharing environment and also a common repository of explicit knowledge in which the members can contribute individually registering their knowledge, in various forms, from better product development practices, to papers, theses, etc. It is available for limited access to the members in the URL http://www.pdp.org.br.

The knowledge portal is composed of 4 principal modules, described in a very succinct way as follows:

♦ **Registers and Sentences**: The registers can be all documents, or any one of them, generated during the product development process, such as meeting minutes, drawings, procedures, cases, bibliographical references, reports among many others. The sentences are a specific type of knowledge said to be structured, that is, which has a standard format, representing a specific idea in the form of rules containing a subject and a verb.

♦ **Reference models**: are representations of the activities of a process, which can be general or specific. They are integrated with specialized software for the modeling process which permits the immediate generation of HTML pages or the original document for download.

♦ **Knowledge pages**: are special pages which have a study itinerary for the user to be initiated in a certain theme. They have an introduction and links to the various types of explicit knowledge (registers, sentences and models) regarding this theme. This module allows a layman in a certain subject to have an itinerary which orientates him at first contact with the subject.

♦ **People and knowledge**: it is the module which contains information about a group of users registered in a system, that is, a community of people which is sharing knowledge. It has as a functionality for the information of the domain areas for each user, that is, a selection of the knowledge and experience which a user has.

The division into modules has the purpose only of guiding the users in the search for the main types of knowledge. The knowledge of one module is interrelated to that of the

others through keywords, and the registers can be related with the sentences and both with the reference modules.

The portal further allows that searches through the means of keywords can be carried out, recovering all the content which is classified according to the word chosen regardless of the module to which it belongs. For example, choosing the keyword, "*project management*" gives as results, people who know this concept, along with articles, theses, events, reference modules and also knowledge pages.

Further regarding the portal, it can be noted that each piece of knowledge available is linked to a user, so, to utilize the portal it is necessary to be registered and posses identification (login) and a password. Therefore, it is possible to define levels of user access according to the interests and policies defined by the administrators and also to give security to those who contribute with knowledge.

It is important to highlight that the portal allows the personalization of this tool for the various environments and forms of utilization. There follows the PDPNet community initiatives developed for the sharing and creation of the groups of knowledge which are carried out with the indispensable help of the portal.

7.3. Other initiatives developed by the PDPNet community

The main activities developed by the community are:

♦ ***Conceptual discussions***

Carrying out of meetings and workshops for the discussion of the concepts related to the product development process, aiming to unify, together, the terms and meanings necessary for the creation of content. This initiative allowed the members to realize that many concepts were understood and applied in the same way, although they had different denominations, due, mainly, to the origin of each group, which brought with it a more intense load in one or another area of knowledge. These discussions have been fundamental in the minimization of differences, which can impede effective changes and sharing among members. The presentations carried out with all discussed content, as well as meeting minutes, were placed in the portal to facilitate the access for those who did not participate in the discussions, and also the exchanged knowledge was stored in a common repository.

♦ ***Mapping of themes of interest in the product development process***

A survey was carried out among the group members on the themes of completed studies, of ongoing studies and of themes of interest for future studies. The objective of this survey is to facilitate the identification of the common points among members, as they were already known to be complimentary, however, they were not known more profoundly, for the definition of the co-orientations and creation of research projects together. Furthermore, in this process of mapping themes of interest, the members could know a little of the history and of the future perspectives of each group, enabling the development of trust and comprehension of the viewpoints on certain activities and the understanding of concepts among them. The themes of interest surveyed were registered in the portal as themes for future study and were also related with the people interested in that particular theme.

♦ ***Interchange of community members***

The community is also composed, in its majority, by research groups, hence by graduate students. The interchange of students was encouraged, facilitating the process of joint content creation and allowing the student to experience another environment, participating in the everyday activities, and in subjects related to product development offered at the institutions during the interchange period. Interchanges are defined based on the survey of the themes of interest. Members of Grupo EI and GEPEQ spent long periods participating in research projects at NeDIP. Similarly, many graduates of this latter group spent a period in GEPEQ and Grupo EI. Various activities were carried out, training for the use of the portal, presentations of studies developed and papers published, the carrying out of case studies together, and short courses on product development. The ongoing studies in each of the groups were also registered in the portal and this allowed people who are carrying out similar research to initiate an effective exchange of knowledge.

♦ ***Creation of controlled vocabulary in the area***

Vocabulary was developed within the community in order to orient the taxonomy or classification of the knowledge shared by the members, showing the relations of synonyms and similar terms in the area, from which the keywords used

in the PDPNet portal were derived. In future, the community should create it own glossary based on this vocabulary, containing a brief description of the concepts presented, for a common understanding. Both should be available in the portal for editing and suggestions for new ideas.

♦ ***Determination of relevant bibliography for the product developing process***

Creation of a list of books on the product development process, gathering the references surveyed within the groups, and submitting a complete list for their individual evaluation from the most experienced members, who gave grades between 1 and 5 (one and five) to each of them according to their opinion on their relevance for the area, attributing 0 grade (zero), should they be unaware of the piece of work. It was noted that even pieces of work considered totally relevant by some, were unknown to others, nevertheless it was also possible to identify which were the indispensable references for those interested in the product development process, along with allowing, also, that the community seeks new information sources increasing their knowledge. The list of books was also registered in the portal and is available for all members who wish to consult it, thus facilitating the process of seeking relevant references and also ensuring that the community doesn't duplicating efforts.

♦ ***Reference model for the product development process***

A reference model is a step by step representation of activities carried out in product development. One of the objectives of the community is to create, in a joint manner, a reference model for the development process. It will be a general model which can be adapted for each type of product according to its particularities and can be utilized for educational purposes and research on the product development process and also the companies which wish to intervene in this process, helping the comparison and understanding of a company reality. This generic model must allow that various specific models are development in the future for different industrial sectors and/or products types.

This is the activity of greatest joint content creation in the community of practice and also one of the most interesting in terms of knowledge sharing. The creation of a model has allowed that researchers, specialists in certain phases and parts of the process, contribute with their knowledge for the creation of a strongly interdisciplinary joint model. The discussions about different points of the model have allowed a uniformity of language and exchange of experiences, bibliographies and ideas, along with a greater approximation in terms of personal relationship.

In the future, the model should be utilized to facilitate the teaching of technical level company personnel, allowing the performance of activities outside the normal workplace in a University-Company integration. Furthermore, this community also has as a goal, the carrying out of all the unfolding of this mapping process for each one of the activities in its various dimensions, for example, necessary information, resources that it consumes, activity costs, etc.

The reference models developed and under construction by the groups have also been stored in the portal, facilitating the access for those who cannot participate in the meetings and wish to follow them and contribute with suggestions.

Thus, it can be noted that the practices and initiatives developed always have in common the use of the portal for sharing, and the community working together, with their experiences, for the creation of new knowledge, minimizing the partial views of the product development process and also seeking to integrate the differences and potentialize the capabilities of those involved.

The whole community has been encouraged to share in the portal their sources of information, their resources to develop specific activities and also their knowledge, even when it deals with experiences or knowledge on the literature.

8. Implications for the companies which develop products

The immediate benefits of the creation of these communities of practice have been previously presented in this paper. To improve the university-company relationship and unite the capabilities of the researchers in the area of product development management are certainly the two most important. However, this experience of stimulating communities of practice and the initiatives presented could also be useful to the companies which seek to improve their product development process.

These companies generally need to involve various specialists, even from outside the realm of their organizations. They are professionals, suppliers and clients, strategic partners in the development of their products. One strategy to

maintain the capabilities of these people would be to create communities of practice in subjects/technologies which are key to the company. Researchers from universities and research centers could also take part in this effort, actively participating in discussions and carrying out joint research, which fulfill the technological needs of the company.

The potential benefits of the creation of a community of this kind are:

1. the continual progress of professionals who work in the development area of the company, by means of experience exchanges with more experienced colleagues and with external professionals and researchers.

2. it facilitates the cooperative work within the engineering environment, allowing a greater uniformity of concepts and an approximation among the engineering professionals. This is particularly important in big organizations.

3. the community can assist the company professionals to solve the development problems in a rapid and efficient way, giving tips and orientations.

4. the community can become a source of information the moment it seeks new professionals and new capabilities.

5. it permits an efficient link with entities such as universities and research centers, fundamental for the company to manage to have access to state-of-the-art technologies and carry out innovations in their product lines.

Some concerns and issues, not discussed in detail in this paper, need to be considered in cases of applications of this type. In particular, questions of intellectual property need to be addressed, which must be well defined in the community code of ethics.

9. Final Considerations and Conclusions

The creation and use of knowledge in organizations are practices which are ever more valued and considered strategic. Therefore, the opportunity for exchange and sharing of knowledge in a community of practice can support the development of the most creative activities in the application of knowledge.

The creation of a community of practice in product development has been relevant to the divulgence of the strategic importance of this process in companies. Members of the community have also learned from the companies by way of case studies, sometimes on specific themes in this process, seeking to offer with this learning a more uniform vision for the different productive sectors regarding the concepts, methods and tools to be employed in product development.

The utilization of information technology by way of a knowledge portal has been of great benefit for the sharing of knowledge in the PDPNet community of practice. The portal has accommodated the knowledge generated and utilized for the development of other initiatives relevant to the creation of new knowledge in the community.

It is possible to perceive, therefore, that in order to have effective knowledge management, it is necessary to have motivated people, willing and prepared to share knowledge among themselves, much more than a tool, however, it be a great facilitator, as in the case of the PDPNet community of practice.

Thus, the PDPNet community has been reaching its objectives, gathering people interested in the product development process. Initially restricted to people originating from universities, but today already counting on members from many companies that develop products which are bringing experience of practical performance and real cases to the community.

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