Supporting Expertise Awareness: Finding Out What Others Know

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ABSTRACT

This paper presents an innovative approach to solve the problem of missing transparency of competencies within virtual organizations. We based our work on empirical studies to cope with the problem of competence finding in distributed organizations. Former studies have shown that central storage of expertise profiles is inappropriate due to missing flexibility and high costs of maintenance. The focus of our approach is to support peripheral awareness to become aware of the available competences in organizations. Our approach runs along two lines: making expertise-related communication visible for all members of an organization and visualizing competence-indicating events in collaboration infrastructures. We verified this approach by the evaluation of a prototypical implementation.

Categories and Subject Descriptors

H.4.3 [**Information Systems**]: INFORMATION SYSTEMS APPLICATIONS—*Communications Applications*

General Terms

Human Factors

Keywords

Human-Computer Interaction, Knowledge Management, Expertise, Awareness

1. INTRODUCTION

Many modern organizations can be seen as network organizations. Their participants are individuals as well as organizations, which cooperate in distributed teams. Especially in knowledge-intensive domains (service engineering, consulting, etc.) project teams are made up of participants from different disciplines and organizations to unite their special competencies and to match project necessities. Problems occur when trying to establish a shared knowledge management for those teams respectively for the participating individuals and organizations. An important challenge is to give mutual orientation of the respective competencies to every team member, as it is usually embedded in the cultural practice of collocated work settings. Consequently, when thinking of computer support for distributed settings, not only shared distributed knowledge databases and appropriate retrieval systems have to be organized but also the missing peripheral awareness[1], which is essential for working within a team has to be compensated electronically.

Our approach concentrates on the demand that competencies within a network or virtual organization (see Picot et al. [19] or Mowshowitz [16]) have to become more transparent. Members of "traditional" companies get to know each other in a "natural way" through office sharing, business lunches, periodical meetings, etc. Virtual organizations are characterized by highly distributed work scenarios, mainly computer-based cooperation, highly (organizational as well as legal) independent partners and project-based cooperation (varying degrees of temporality). With this collaboration topology, maintaining peripheral awareness of the available competencies of individuals in the network becomes a problem. Some reasons can be derived from the characteristics of virtual organizations and the missing shared work practices and organizational cultures [20]. The three most important reasons are:

- Lowered motivation to present own competencies (perceived cost-benefit-balance)
- Difficulties in building a common organizational culture (because of the fragmented work settings)
- Lowered willingness to participate in group activities and to work for the shared infrastructure

The extensive use of computer-based communication and cooperation can be seen in two ways. On the one hand the expressiveness of communication is lowered by media

[1]The term peripheral awareness describes all incidental noticed information about a person, like the preferences of this person or details of its character.

like email, in contrast to personal face-to-face communication. On the other hand the use of information and meta-information that is automatically generated by the use of computer-based cooperation tools offers new opportunities for knowledge management support. The solutions that have been considered in research so far were either based on stored information about individual expertise ("yellow pages" approach, see Hahn and Subramani [9]) or based on intelligent strategies to detect and present expertise (e.g. by using recommender systems, see McDonald and Ackerman [15]). The approach we present here describes a third way that aims at providing peripheral awareness of expertise-indicating activities. The approach is based on the concept of awareness systems for groupware infrastructures ([7], [27], [12]). We try to make individual expertise more transparent by the use of three techniques. First, we provide observable expertise-related communication. Second, we try to capture competence-indicating parts of the daily working processes (e.g. writing many documents about a specific topic – like "knowledge management") and third, we generate information based on derived hypotheses on the competencies of group members.

In the next section we will give a short overview about existing work that deals with the idea of supporting peripheral awareness within groupware settings. We unite this discussion with a controversy about the use of expert finding strategies. Our discussion will not focus on organizational aspects that arise from the introduction of such expert finding strategies. A detailed view on this issue can be found in *Working knowledge* [6]. After the discussion we will describe our view on virtual organizations and the results of a pre-study we did. In this study we identified problems regarding the use of knowledge management concepts. Finally we present our concept of Peripheral Expertise Awareness (PEA), a first prototypical implementation of this concept and the results of its evaluation.

2. STATE OF THE ART: AWARENESS SYSTEMS AND EXPERT FINDING

In most virtual organizations collaboration is done via groupware systems. Such systems provide several communication techniques like email, video-conferencing, shared workspaces, news groups and workflows and some of them have even integrated awareness facilities (cf. Mark et al. [14]). These facilities contain awareness services to generate information about the working and using behavior of the system's users. For example, the system notifies its users if a document was replaced or an email was sent. Research on electronic support of peripheral expertise is done for more than a decade. It is derived from the idea that in work context not only explicitly published information are relevant, but also implicit ones [10]. This idea was integrated in the context of computer-supported cooperative work, where events relevant to the working context are stored and distributed to the users (see Dourish and Bellotti [7], Rodden [26] or Benford and Fahlen [5]). There are two problems with these approaches: First, the privacy of the users is tangled [28]. Second, most of the information generated and distributed by the system is irrelevant to most of the users [11], [28]. Those problems are usually addressed by configurable awareness systems (cf. Rauschenbach [23]) and have to be considered whenever implementing an awareness system into an organizational context.

The problem of making competencies transparent can be seen as a part of the more general problem of broadcasting meta-knowledge. Krogh and Venzin [31] discussed five main tasks that have to be performed by knowledge management[2]:

1. Make knowledge (e.g. experiences, best practices) accessible for the whole company.
2. Make knowledge accessible at the time and place of decisions.
3. Make it easy to develop new knowledge efficiently and effectively.
4. Make sure that all employees of the organization know where which knowledge is available.
5. Utilize knowledge in new products and services.

The technological support of knowledge management within organizations was mainly based on the idea of creating an organizational memory (see Walsh and Unger [32]). This resulted in the management of huge distributed information bases (i.e. [3], [9]), which has some shortcomings. For example Bannon and Kuuti [4] noted that these solutions isolate knowledge from the working processes in which it is needed. Other approaches concentrated on the support of communication (see Ackerman and Malone [1]), because not all knowledge can be made explicit (see Nonaka and Takeuchi [18]). In this context the idea of cooperatively adaptable virtual information and communication spheres was discussed (cf. Shum [29]). Recent approaches take into account that not only information has to be stored and organized, but also information resources and human experts (i.e. Ackerman and McDonald [2], Yimam and Kobsa [33] or Reichling and Veith [24]). Most of these approaches try to provide database-oriented approaches (see Hahn and Subramani [9]) or fully automated approaches of expertise detection. Groth and Bowers [8] argued that the expertise recommender approach from Ackerman and McDonald [2] uses heuristics that may work in some special application fields, but may not be transferable to other application fields since they implement hidden assumptions about the availability of experts. Instead, they suggested providing an awareness system that helps understanding a group's working context and thus the available expertise. Their strong criticism of McDonald and Ackerman has been rejected by Pipek and Wulf [22], since the availability of additional recommender-based approaches does not restrict other expert finding strategies. In addition, they were able to describe the strong cultural and organizational dynamics that influence expertise management.

3. EXPERTISE MANAGEMENT IN A FREELANCER NETWORK

We conducted a long-time study in the freelancer network SIGMA (a detailed description of the organization follows), which is an organization of trainers and consultants. This field of application seems to be especially well suited for

[2] Uncommitted translation from German to English by the authors.

technological tools to support expertise sharing, because it has many in common with a virtual organization and the network is equipped with a technologically well-working infrastructure. However, our study shows considerable problems when trying to support the sharing of expertise with a technological system.

The primary goal of this study was to get to know the pattern of knowledge sharing in SIGMA as well as the problems of these patterns. In our research, SIGMA exemplifies a network organization in which autonomous entities form alliances to market complex services. For this study, we conducted twelve narrative interviews with different network members, who differed in their role in the organisations' hierarchy, their level of computer expertise, and their length of affiliation with the network. The interviews took between 45 and 120 minutes. Most of them have been recorded on tape. The interviews consisted of a free narrative part ("Please describe your work within SIGMA.") and questions about knowledge acquisition and knowledge transfer in the second part. The narrative interviews have been complemented by unstructured interviews with key role players (managing director, project manager). Additionally, several regional and administrative meetings as well as several annual meetings of the associates have been observed. The interviews were part of a long term research effort within this network organization (cf. Rittenbruch et al. [25] and Pipek et al. [20]). We analyzed the material along three lines of interest:

1. The media used for information transfer and storage
2. Problems, regarding the organization of information flows within SIGMA
3. How new members are successfully introduced into the network culture

SIGMA is a network consisting of more than 200 entrepreneurs and freelancers and has the legal form of a Limited Liability Company. Apart from a few employees whose work contributes to the infrastructure of the network (e.g. secretaries), the network does not employ members on the basis of traditional labor contracts. Instead, the individual members are freelancers with a variety of payment modes. The network offers several financial, infrastructure-related or administrative services to the associates, who in turn contribute 10% of their benefit to fund the network services. About two third of SIGMA's total revenue (approximately 10 million USD) comes from IT courses. The courses of SIGMA cover a wide range of issues from teaching basic computer skills in specialized classes to management courses. SIGMA's clients range from job centers to fortune 500 companies. Further activities are in the fields of business consulting and software development, especially groupware configuration and computer-based training applications.
Besides four managing directors, SIGMA has no formal organizational hierarchy and perceives itself as self-organizing network. Therefore a network member's position can vary over time (e.g. shift from project member to project manager). Some freelancers work alone, but most of them developed partnerships with members with a complementing expertise to offer more services to their clients. Nevertheless, there are informal hierarchies that relate to client ownerships, regional contacts and the number of contacts in the network. Some dependencies between network members are very similar to those in small companies, and the teams that form may persist over several projects. The high level of self-organization and the flat formal hierarchy allows SIGMA to act flexible within dynamically changing markets.

SIGMA always relied on a shared technological infrastructure. In 1995, an intranet-based Bulletin Board System with a messaging system and a file sharing area has been introduced. It was replaced by a "Lotus Notes"-based System in the year 2000. Only the intranet server is included in the infrastructure service of the network. All other infrastructure costs have to be covered by the network members themselves. The same applies to training, software and communication (phone/internet). Almost every member of SIGMA possesses his own personal computer with internet access and a mobile phone (cf. [30]).

3.1 Expert Finding in SIGMA

There were basically two different perspectives of SIGMA's members on the need to know about the expertise of other members. On the one hand, individual needs are defined by persons who have a problem and search for an expert who may help. On the other hand, there are organizational needs, because every organization or team leader has to know about the existing competences. These needs influence project work and team building and have to be taken into account when outlining the future perspective of the organization. Especially in knowledge-intensive domains, like in the case of SIGMA, one has to take a careful look at developing expertise over time, because human resources and therefore knowledge are the most important factors of production in these domains. During our study we identified several problem cases for a lack of transparency of expertise within SIGMA:

- Individual education: A person wants to ask an expert in a field of expertise, which is new for him.
- Project team building: A team leader has to find a new person with certain competencies since the "usual experts" are working already in other projects.
- Ad-hoc-acquisition of follow-up projects: After finishing a project the customer asks for another project with a slightly different focus, but it's not obvious that the necessary competencies are available.
- High probability of "doing the same job twice": Best practices can be adapted and used in a new context if they are mediated by knowledgeable persons.
- Integration of new members: Competencies of new network members have to be assessed and new members have to familiarize with the available expertise.

All of these problems show that transparency on the expertise of cooperating partners is needed in many ways. Usually organizations try to address this problem through maintaining profile databases or similar information spaces (e.g. yellow pages). However, our observations, described in detail by Mambrey et al. [13] and Pipek et al. [20], covered several failures of establishing expertise profiles in highly dynamic organizations. By analyzing the case of SIGMA, we were able to identify several reasons for this failure, which can be generalized for all virtual organizations:

- Cost of Updating: The cost of updating the expertise profile was considered too high compared to the possible benefits.

- Informal Hierarchies: Some resistance against the transparency of expertise came from informal hierarchies. Some senior network members had trained junior members in relevant skills and wanted to have exclusive access to "their" team members.

- Exaggerated profiles: Some concerns were raised about the validity of expertise profiles since network members would claim expertise that they may not have in an adequate quality.

- Visibility of in-competencies: Every approach to make the competencies of individuals explicit may also make explicit their lack of competencies. Therefore this may be a strong motivation to exaggerate profile descriptions.

- Diverging Ontologies: The descriptions of competencies were by far not coherent. Experts from different educational and experience backgrounds would use different terms to describe similar knowledge or different expertise with the same words. The necessity to agree on a single terminology was argued to be one of the strongest points against a profile database.

It was also interesting to see that - when asked for possible support for expertise finding – the very same persons that expressed the need for very specific search options when looking for information (to exactly find what they need) wanted to have a very general profile of themselves in the searched database (to fit as many requests as possible).

SIGMA also had developed several conventions for the document-based knowledge exchange. We discovered in our research that these conventions led to the different attitudes about explicit knowledge representations. When the members were asked whether they would give away material (e.g. for teaching) they had produced, almost all interviewees said they would give it to anybody in the network. But when we asked details, several expectations about the knowledge transfer have been expressed:

- *"I want to know what my material is used for."* This is meant to informally control whether the material is used in the right context and whether some kind of financial compensation can be expected.

- *"I want to have feedback, if the material served its purpose."* This helps the creator of the material to improve the quality of the material and how it can be modified for different contexts.

- *"If the material was modified, I want the modified material back."* This turns the information transfer into an act of collaboration.

- *"I want a trustworthy handling of my material."* This addresses especially whether and how material should be forwarded to third parties. Material forwarding is socially controlled. In general, forwarding is tolerated if the author was notified.

Sometimes material is reused by its content and sometimes only by its structure (e.g. training concepts). Some materials became a "public good" within SIGMA after some time, because it served as a good example. Some material is forwarded with the explicit condition that it is not used or cited literally, like training concepts and material which have been developed for a client. Of course the whole process is a matter of trust, personal recommendations and informal guarantees that help to navigate through SIGMA when looking for material. All material must strictly circulate within SIGMA. These conventions are not generally known, because they are not explicit, even if all of them have been described in the same way by different network members. For most interviewees it was a conscious decision to be the "portal" of their own information and material. The request for material was considered as a valuable act of communication and as an opportunity to get news about new projects, rumors and initiatives within SIGMA. The person who is asked for material gains knowledge on new projects or new persons in SIGMA, since these situations are the typical situations in which material is being requested (e.g. to prepare for a new training). The requesting person can get additional information on how to approach the new project, where to find additional information or material in SIGMA and who can be valuable to talk to, regarding further projects.

3.2 Implications for the design of Expertise Finding Support

From the experiences we described above, the most important thing was to acknowledge the differing requirements that actors see when they are looking for expertise and when their own expertise is presented. As an information seeker, information should be as specific and accurate as possible, while there are numerous reasons to blur the own presentation of expertise when being considered as an information resource. We concluded the necessity for a decentralization of expertise assessment as one important implication for design. It is necessary, because one point of reference for expertise, which is visible for all, is one of the sources of denial and misuse of explicit representations of expertise. It is inherent to these approaches that the identification of expertise has to be done prior to the presentation of expertise information. As described before, this may result in inaccuracies due to missing updates or misuse and corruption. With a decentralized approach to expertise assessment, this behavior would not be possible anymore. However, a centralized assessment also brings benefits with it. It is easier to find orientation if there is a central resource of expertise representation and it is not necessary to develop own interpretation strategies for appropriate expertise assessment. The approach that we developed tries to address these issues too. Therefore our approach follows two lines of research:

1. *Integrating communication channels to experts into knowledge and best practice bases:* Several authors (cf. Ackerman and McDonald [2]) deal with the concept to enhance knowledge bases or case-based reasoning systems by communication channels, which allow direct communication with experts. First, it shows the need for knowing about expertise. Second, observable communication seems to be a very important way to share knowledge [21].

2. *Using notification services to provide peripheral awareness of expertise:* We explore all activities to offer a semi-automated observation for those of the other's activities which might indicate (the gain of) expertise. The goal is not to automatically protocol expertise in a database, but to enrich every individual's work context with up-to-date information for building a mental model of available expertise.

While we consider both aspects as equally important, we focus on the latter in this contribution.

4. SUPPORTING EXPERTISE AWARENESS – THE EXACT IDEA

To deliver a peripheral awareness that can be helpful for learning about each others competencies, we developed the 'Expertise Awareness Client' (eXacT). The indication of expertise is mainly done by interpreting pieces of information that can be sensed automatically from use behaviour of users. For example, one could say that people who are called very often and then always talk about Java, J2EE, etc. seem to be experts in the field of object-oriented programming in general and Java in particular. Therefore an awareness system, integrated into a virtual organization's groupware, could be very helpful for discovering expertise. After all, much of the needed information (i.e. reading newsgroups, answering emails with the topic "Java") can be generated by the system. Figure 1 presents a conceptual view of the system. It describes the correlation between events[3], hypotheses[4], constraints[5] and specificators[6]. Events are available in every groupware system. They can be enhanced by text retrieval techniques to provide a more precise differentiation. For example, if a user posts a message in the groupware system, it's not only possible to generate the event "posting a message". The system can also analyze whether this posting is a question or an answer. Those events are needed to corroborate a hypothesis like "Java expertise" as described above. Our idea is to automate the corroboration of hypotheses.

Furthermore, every user of the system might use the hypotheses from a different perspective. For instance, a programming novice might think of a programming expert as someone who is interested in the Java Programming Language for at least seven months. Programming experts would regard such a person as advanced but not as an expert. Therefore it is necessary that the design and combination of the specificators can be done individually due to different interests and experiences. The eXacT system can be described as an enhanced awareness system. It is depicted in figure 2. On the left side there are several events from a groupware

[3]Events are generated by the system (e.g. user X read document Y).

[4]A hypothesis is a link of atomic events that express some specific expertise (e.g. Java expert := attending Java tutorials and reading news about Java).

[5]Constraints are thresholds, which improve the quality of a hypothesis (e.g. writing only one newsgroup article about Java is not sufficient to label the author as an expert for Java).

[6]The definition of specificators allows the user to combine two or more hypotheses to a new (stronger) one (e.g. to be "interested in Java" and to be a "Java expert" is a stronger hypothesis to identify Java experts than using only the hypothesis "interested in Java" as an indicator for the expertise in this field).

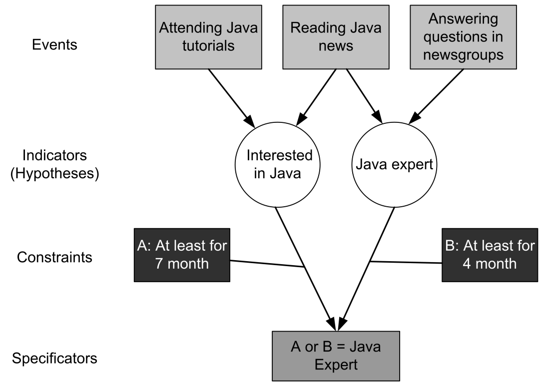

Figure 1: Events, Hypotheses, and Specificators

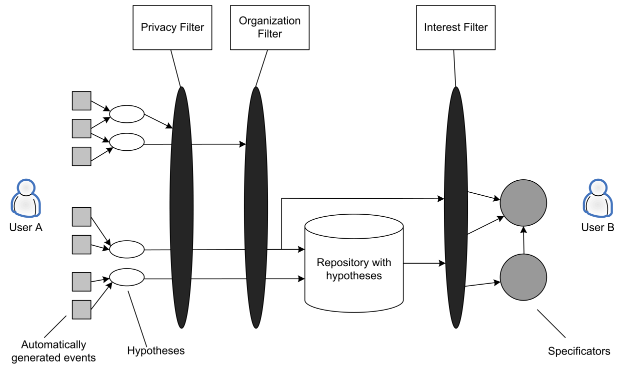

Figure 2: eXacT awareness model

system (i.e. "Document X was opened" or "Newsgroup Y was read"), which are used as indications. Those indications can be the events themselves or can be accumulated events like ("User X reads newsgroup A regularly"). The indicators are connected to hypothesis objects which are used to define/express the meaning of one indication or the combination of several indications (i.e. "User G is an Expert on topic C"). On the other hand, users are able to modify incoming indications by self-defined specificators. Those specificators are used to redefine a hypothesis or to combine two or more hypotheses to a new (stronger) one. For example, let us say there are two hypotheses. The first indicates that someone is a good programmer and the second indicates that someone is interested in the Java Programming Language. Both hypotheses could be combined to a new hypothesis to decide if someone is a good Java programmer. These two steps are the core of the eXacT idea. The previously described hypothesis is integrated into a "traditional" awareness system, where hypotheses events are stored and distributed to other users. Like in traditional awareness systems, our model deals as well with three filters (cf. figure 2). The privacy filter is needed to prevent users or user groups from seeing all the hypotheses which are fulfilled. As in traditional awareness systems it is not always wanted that all colleagues can get all the information which belongs to one person. Additionally to this filter, there is an organizational filter which filters indicators according to the organizations' policy. The third filter (interest filter) is needed, because a user might not be interested in some topics.

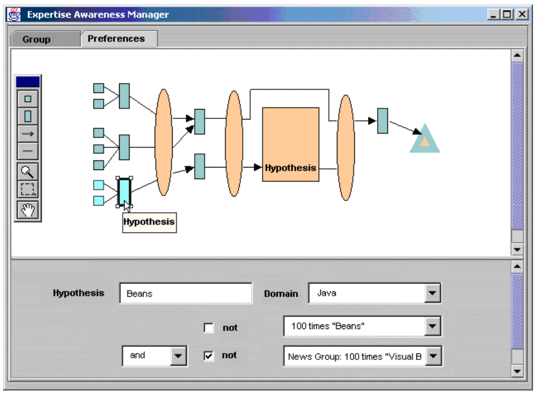

Figure 3: Expertise Awareness Manager

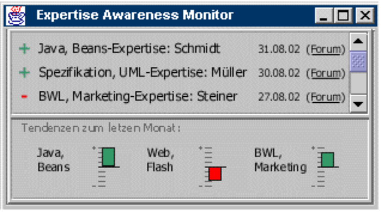

Figure 4: Expertise Awareness Monitor

Events as well as indicators have to be chosen/defined individually for each organization. They are adaptable, because interests, as well as working styles, change and emerge over time. The Peripheral Expertise model was implemented in a first prototype. The indicators were connected to a newsgroup system, and later, during the evaluation, to a chat system. There, all information can be scanned easily, because it is text-based. As we can see in figure 3, the Expertise Awareness Manager (EAMa) allows adding, removing or changing indicators as well as the graphical description and composition of hypotheses. Its visualization is based on the eXacT awareness model in figure 2. As described above, there is a continuous need for the reconfiguration of the system, which should be done by the users themselves. They are the ones who know their domain and working behavior best. Therefore the configuration of the system had to be as easy as possible.

Figure 4 shows the Expertise Awareness Monitor (EAMo), which presents the current changes in available expertise in some topic together with the expert who caused the event. The design was taken from existing awareness models (cf. Mark et al. [14]). The use of a news group system as communication medium and basis for the implementation of our indicators has several advantages:

- Available information: All information that is scanned by the eXacT system is public.
- Easy scanning and further processing: The source information is in plain text. Hence the indicators can be implemented using well-known text analysis techniques.
- Public communication on expertise: Using news groups in loosely coupled cooperation scenarios can have positive effects as private discussions become public. Thus, peripheral expertise awareness is enhanced simply by public availability of communication data within the group.

4.1 Validity of Hypotheses

With the Expertise Awareness System, members of a group have the possibility to visualize expertise and their sources within an organization. What remains is the problem to decide whether the indicated information is valid. It is hard to provide any technological support for this task. There are basically two ways to get valid information. The first possibility is choosing indicators not only to filter information that is not needed but also disabling indicators that are based on hypotheses that might be weak. The combination of indicators, which is done in the specificators, can help also. Weak hypotheses can be combined to be strong enough to indicate the competence of the monitored person in a specific field. The second possibility to get valid information is to use individual validation techniques. Here, a heuristic approach is used to find strong hypotheses by analyzing the individual configurations of the group members. For example, if many users think of an indicator as very helpful this hypothesis is marked as strong. Furthermore, transitive relations can be introduced to weigh users and their use competencies. If an experienced user marks a hypothesis as strong this is interpreted as a more important piece of information than if a beginner does it. This technique is used in many groupware systems. For example, there is a community[7] which tries to identify spam mails this way. Spam mails are marked by the uses of the group. The more trustful a user becomes, the more his decisions count.

5. EVALUATION OF EXACT

With the eXacT concept we described here, we have achieved our design goals. The system interprets the data available as expertise-indicating events according to rules that have been specified by individual users in a decentralized way (cf. Figure 2). The subjective perspective is maintained by allowing every user to build and/or choose the hypothesis generator he trusts most. By the visualization of trust, which the users put into one generator, and by allowing every user to use generators the other users constructed, there is a way to establish a shared perception of what is considered as "good" expertise indication. This feature covers one benefit of centralized expertise awareness approaches.
Unfortunately, SIGMA underwent a deep reorganisation at the time we evaluated our prototype, and it was not possible to evaluate our prototype within SIGMA. We found a smaller company that shares important, but not all characteristics with SIGMA. EPSILON is a small company that develops numerous web applications from web sites and shop systems to business planning games and is also responsible for training future users. It has a core of six employees, but is also part of a network of about 30 other small companies and freelancers. Contrary to SIGMA, this network does not have an organised shared infrastructure, but shared infrastructures between cooperating partners are being build in every project. But EPSILON and its network also share important characteristics of SIGMAs work environment. Work is organized in distributed settings involving home offices

[7]See: `http://www.cloudmark.com/desktop/community/`

and client offices, it is knowledge-intensive work, and it is organized in projects and project teams. We concentrated in our evaluation on usability issues and on aspects of embedding the eXacT prototype in work practice, which was plausible in our eyes although we had to change the field of study.

5.1 Methodology

The evaluation of the eXacT system was done with the thinking-aloud-method from Nielsen [17]. The method makes it possible to get information about the behavior and thinking of users during the evaluation process. Our goal was to evaluate our ideas regarding the following issues:

- Usability of the user interface
- Integration of the system into the work process
- Usability of the available methods to discover the expertise of others
- Adequacy of the presentation method for the peripheral awareness

Three employees of EPSILON were selected as reference users for the evaluation of the system. They were monitored during their direct and indirect (peripheral awareness) use of the system. Two persons (P1 and P2) are considered as IT experts, while the third person (P3) is considered as layperson. The employees got only some information about the purpose and complexity (groupware module, plus the eXacT system) of the system they had to use. They got neither any information about how they could use the system, nor any screenshot. At the beginning of the study the users were asked about their experiences with knowledge management tools and groupware tools:

- **P1:** Java-Developer. Is experienced in installing and using Lotus Notes, Microsoft Outlook, web-bases forums, content management systems and some online groupware tools. He uses online communities to exchange knowledge about Java.
- **P2:** Java-/Web developer. Is experienced in using Lotus Notes, Microsoft Outlook, web-based forums, content management systems and different online groupware tools.
- **P3:** Commercial clerk. Is experienced in using Microsoft Outlook and uses online forums from time to time to exchange information about the utilization of office software.

The evaluation was divided in three different scenarios, which should reflect some common processes, which we discovered in SIGMA:

1. The layperson should use the system to discover Java expertise.
2. The layperson should question one expert, corresponding to the previously discovered expertise. The other expert should use system to discover their expertise.
3. The system was without any limitations used with all hypotheses that were constructed in the previous scenarios.

The evaluation took place at the interviewees workplaces. P1 and P2 did work together in earlier projects, while P3 was rather new in the organisation. All scenarios were played during ordinary work hours in one day. Scenario 1 and 2 took about half an hour each, Scenario 3 had an open end. The persons were observed throughout the day and notes were taken, but recording was not used.

5.2 The first Scenario

The system wasn't configured at all. Each user had only access to the hypotheses he created himself. The IT experts were asked to use the chat-system of the groupware module for their communication, while the layperson should use the system to discover Java expertise. P1 had no problems with the system and explored all parts of it. He even explored the hypotheses editor, although it wasn't an objective for him in this scenario. He formulated a hypothesis with the terms "test" and "Java". It was no problem for him to use the hypotheses editor and he remarked that the structure of the editor is similar to an FTP (File Transfer Protocol) client. P2 was puzzled about the fact that he had to login right after the start-up of the system and that he wasn't able to explore the system before the login. He noticed the good structure of the graphical user interface and said that the system is easy to use. He browsed all modules of the system, but made no adjustments. In contradiction to P1, he formulated no hypotheses. P3 had no problems at the start-up of the system, but he didn't know what to do. The functionality of the system was not obvious to him, but he was able to explore it. Even if it wasn't intended in his role, he browsed to the chat and watched the communication of P1 and P2. After a while of watching he believed to know what to do. The hypotheses concept was hard to understand for him, because he thought of actively searching for Java expertise. But he found the handling of the application easy and was immediately able to enter a formula in the hypotheses editor. He constructed the following hypothesis: `10 times 'Java' AND NOT 10 times 'C++', Section: Programming/Java`. After the construction of the hypothesis, he went back to his normal work. After a while he observed that the system seemed to be idle and traced it back to the fact that the others didn't type at all by intension. Therefore he changed his strategy and created a new hypothesis to see what's going on in the chat: `5 times '[name of the projects the colleagues are working on]' OR 5 times '[Name of a colleague, who works in the projects]', Section: Contacts`. After some time, during a telephone call, he saw the result of his new hypothesis, as the "contacts-symbol" popped-up. Right after that he changed his options again and created another hypothesis: `1 time '[name of P3]', Section: Contacts`.

5.3 The second Scenario

In the second scenario the layperson was asked to communicate with an IT expert about Java. The layperson should question the IT expert about his discovered expertise. Meanwhile the second expert (P1) should discover the Java expertise of his two colleagues. P1 had the task to configure the hypotheses constructor to be able to discover the Java expertise. It wasn't a problem for him to do this with the adjustment: `(2 times 'JBoss' OR 2 times 'jboss'), Section: Programming/ Java`. For him it made no sense to search for "Java", because it was clear that his two colleagues will talk about Java. After a couple of minutes he got his result, as the "Java-symbol" appeared on his screen. Right after the appearance of the symbol he did some changes: `(1 time 'JBoss' OR 1 time 'jboss') AND (1 time '[name of P1]' OR 1 time '[name of P1 (lower case letters)]'), Section: Programming/Java`. This new hypothesis led to another notification by the system and proved his assumption that his colleagues are talking about the coordination of the project. P2 and P3 made no changes in the configuration of their hypotheses constructors. They only used the chat in this scenario to talk about the work in their projects.

5.4 The third Scenario

In the last scenario the users could use their own hypotheses and all hypotheses of the other users. All persons had to do the same tasks as in the first scenario. P1 and P2 used the chat to exchange messages and had a discussion about the execution of the project. They were very pleased about the easy handling of the application, but remarked, that it is quite complicated in the long run to adjust the hypotheses over and over again. P3 used, as expected, the adjustments that P1 had made in the second scenario. He just had to change the name of the employee.

5.5 Analysis

The integration of the system into the daily work process seems to be possible with the presented concept. At the beginning the users were concentrating on the system, but after a while they went back to their daily work. No user was interrupted during his work by the system. The unintended configuration of the hypotheses constructer, regarding the intended roles, enables us to draw conclusions about the use of this system to mark and discover expertise. The users knew – except P3 in the beginning – that the expertise determined by the system is only hypothetical. Thus they interpreted the expertise in the context of their work. Initial use problems were caused by the users' expectation that they can actively search for expertise using the system.

P3 used the potential of the system to "listen" to the things the others were doing. P1 had no problems at all to use the system for his purposes. He made adjustments to notice the expertise of the enterprise. The applicability of the system to support peripheral awareness was particularly visible in one case where P3 recognized a message from the system during a telephone call, although his eyes weren't fixed on his screen. This activity of the system didn't interrupt him and had no negative impact on his call. The users had to define simple hypothesises in the scenarios, but they started to leave their intended roles to adjust the system according to their needs. With growing experience regarding the use of the system, the exchange of hypotheses rules seems to work as well as shifting the focus back to the work context without feeling interrupted.

Although the pilot study mainly dealt with usability issues, we also found indicators for the use dynamics in larger groups. For us it was surprising to see that the users started using the names of colleagues when creating hypothesis constructors. They emulated the classical concept of groupware support for peripheral awareness that way, but in this context this results in new opportunities to capture the expertise users assign to colleagues and to make use of it in expertise location. It also creates additional privacy and acceptance hazards, since users may feel uncomfortable with opinions about their expertise that would become public that way. It was not really possible to evaluate how users assess the value of hypothesis constructors created by others, and what type of community support is considered useful when reusing those constructs, but it was confirmed that this type of support is necessary. We could think of using recommender systems, of allowing users to articulate ad hoc their (dis-)satisfaction with hypothesis constructuors and visualize this information, or of supporting concepts like local experts, key users or trusted authors to address the problem of constructor selection.

5.6 Future Work

We focused on the hypothesis creation of the eXacT concept here, but other aspects still need to be tested. The filter concepts of the event pipeline did not play a role in this evaluation and need to be verified. We now developed event generators for applications that use text-based communication, but these generators can be improved (e.g. by adding support to better understand the semantics of a text) and complemented (e.g. by generators observing the browsing behaviour of users, or by generators observing work progress in workflow management systems). Privacy concerns need to be addressed at all levels of the system architecture.

We are currently revising the ideas behind eXacT to better integrate expertise-related communication means and the notification infrastructure. The original implementation will not be continued since it strongly relies on certain products. We are currently re-implementing the idea to build an infrastructure for expertise visualisation that easily melts with many types of existing company infrastructures and that provides an easy way to implement and integrate new event generators for all types of applications.

6. CONCLUSIONS

In modern organizations, especially network or virtual organizations, problems occur when trying to establish a shared knowledge management for the participating individuals and organizations. One important aspect of the problem is the missing awareness of all members which leads to ignorance of the competencies the organization has. We were able to show in our pre-study, what problems database-oriented approaches or "intelligent" approaches of expert finding entail in distributed work settings. As an alternative way of expert finding we suggested to improve transparency of the organization's activities by using awareness systems that deliver notifications about expertise-indicating events that are generated from observing the use of different applications. We used such an awareness system as a part of a knowledge management tool. The so called eXacT system allows users to define hypothesis generators that combine several expertise-indicating events of software applications to generate hypotheses about the (gain of) available expertise. The resulting notifications are made available to individual users either in textual ways within the used communication systems or by graphical representations (e.g. the Expertise Awareness Monitor). The generators can be rated as trustworthy to deliver a good measure of the expertise that they are supposed to indicate and they can be shared by users to allow the reuse of other users' experiences. The hypothesis generators provide a rich environment for peripheral awareness of expertise in a distributed work setting like a virtual organization.

A first prototype of the eXacT system was integrated into a chat system. We evaluated the prototype in a distributed work setting and were able to show that the interface concepts as well as the basic ideas were rated useful. In the future we plan to develop an approach to collect expertise-indicating events by means of flexible technologies (e.g. web services) that cover a broad application spectrum. In that context, we have to put a stronger emphasis on privacy issues and community support. Especially the latter is a crucial for supporting open delegation patterns in our approach. Similarly, the evolving technologies in the field of 'Web 2.0' may enable us to deliver interoperable interfaces that do not relate to a specific programming language in the future.

Our contribution is a plea to re-evaluate "intelligent" support systems that automate the users interpretation work of rating expertise at the cost of decontextualisation of expertise resources (here: human experts). It may well turn out that the understanding of individual users about the expertise, which is necessary in a certain problem context may not match the ontologies and heuristics used to give access to these resources. With our approach, we offer users the opportunity to work with the own mindsets while being able to observe the mindsets of others.

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