Supporting Communities by Providing Multiple Views

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Abstract. A number of dimensions are relevant in order to successfully support community life and development. These dimensions include the easiness and broad spectrum of participation, the provision of value in return to the contributions, the visibility of community activity, the support of different levels of membership, the openness to the external world, and the support for evolving phases of the community life. In this paper we present a system that has been designed in order to tackle those dimensions with a particular attention to participation issues. We present first the sources of requirements that have informed the system design and which include the user observation of two companies. Then we present the system, stressing the features of integration with the daily working environment and the provision of multiple situated views, as a means to address the elicited requirements. Finally, we compare our design choices with a broader set of requirements that we have derived from literature.

Introduction

Communities of practice have been widely studied and acknowledged as a major informal organizational structure, pivotal in supporting learning and high adaptation to innovation and change (Lave and Wenger, 1991). Because of this central role, many attempts have been made in recent years in order to foster their creation and people participation, which include the proper design of technology

in support of them and the deployment of appropriate organizational changes and new processes. These attempts have been however very difficult in several cases, resulting only in a core set of people participating to the community activities and not achieving the broad impact aimed at by the promoting organization. Several reasons could be at the origins of this flop. The first cause, we believe, is due to the top-down approach adopted imposing community structures from the above, instead of aiming at making visible existing activities in the organization areas of expertise and soliciting cross fertilization among areas. This contradicts one of the fundamental attributes of community activity as being spontaneous and bottom-up; asking to participate in them because of management needs, almost certainly ends up in failures because the individual reward is not immediately clear. Community activities flourish in the companies where they do, because people participating in them use them as a place where to give and receive mutual help, a place where to learn and stay up to date with techniques and problems in a certain field. Another issue, related to this one, is that participation has an additional cost with respect the mainstream daily activities, with pressing deadlines and deliverables. When the effort to participate in the community life is too high, e.g. requiring a learning curve of the environment supporting it, or a high time for creating new content, than participation could be less than expected as well.

In this paper we present a system that aims at promoting and supporting participation in communities by making visible the activities going on in the various organizational projects and facilitating participation by providing an integrated working environment where activities both in organizational projects and in communities can be smoothly interleaved. In order to describe our technological proposal, we first describe the set of requirements we have been relying upon. They are based both on existing observational studies of use of community systems and on our own analyses made on two organizations. Then we present how we mapped those requirements into the design and implementation of a system. Finally, we conclude summarizing what we believe are the dimensions where technology design can affect adoption of community support systems.

Determining Community Requirements

The design and implementation of the MILK system, started from a Web based collaborative environment, BSCW (Bentley et al., 1997) that was evaluated as a collaborative platform, on the one hand, already effective to support project based collaboration and, on the other hand, flexible enough to be further extended with features to turn it also into a community support system. Our aim has been to evaluate in which way such a system could be extended in order to be more effective in supporting community activities.

Input to the design of these extensions came from a variety of sources, including ethnographic observation of two organizations and various existing studies of community behaviour and support with technology. In the following sections we report the main issues.

Existing Studies on Community Support

A first study motivating our design analyzed the role of informal communication and the way it articulates in work organizations (Isaacs et al., 1997). In particular, this study reports that there is a category of *spontaneous* communication that happens because two or more people *happen* to encounter each other. These exchanges are among peers, who exchange technical advice, ask support to solve problems and stay up-to-date to interesting results obtained in other projects of their area of expertise. These exchanges are the typical exchanges that happen inside communities of practice, and in the reported study they were made possible by the sharing of a common physical place with its own known rhythms. However, with increased mobility of users and distribution of teams, such a possibility is at risk, because the possibility to cross each other, especially during pause moments of the day, is much less. This led us to identify the first requirement: *Recreate some of the affordances of a common physical place across distributed physical organizational units with a high degree of mobility.* This requirement articulated in recreating the possibility to know about people and some of their activities at the various sites (e.g., who was in the office and who was out, who was currently in the common area) and be aware of their social rhythms, both when in the office and mobile.

A second study informing our set of requirements concerned the use of a community system aimed at circulating relevant competitive information in an IT research environment (Snowdon & Grasso, 2002). This study shows that the potential and actual users could be grouped into three categories: the ones who were actively participating in the system, providing input and getting benefit; the ones who were against sharing information and collaborating inside communities; and, a third category of users who were interested in participating, but to whom the cost of doing it was too high. In particular, this latter category of users reported that the community system was not integrated into their working environment, making necessary learning a new system, and also making an effort to transfer relevant information from one system to the other. This barrier was enough to prevent their participation even if they were willing so and could see potential benefits. This led us to a second requirement: *Decrease the cost of participating in community activities by integrating daily work support systems with community support technology.*

Finally, the same study reported that a reward was expected by community participation in terms of visibility of the own contribution and impact on the community activities, but also on the organizational activities. This was

particularly visible in the study, as there were some modalities to introduce contributions, which were not immediately showing where and how they were going to contribute to ongoing community threads of discussions. This was widely reported as a major deficiency even if—in the analyzed system—this was happening only when submitting new content from the public large screens showing community discussions in the social areas; this kind of information was fully visible through the web interface instead. This led us to a third requirement: *Make clearly visible participation in community activities in a pervasive way.*

The above requirements for technology support have also been compared with the set of requirements relevant to support community activities as articulated by Etienne Wenger (2001), which was confirming their centrality, while allowing us to focus on key issues affecting participation.

Qualitative Analysis of Involved Communities

In order to complement our understanding coming from existing studies, we had also the possibility to work with some user organizations of typical knowledge-intensive character. In the following we recall the main issues and outcomes of the user's analysis; for more details see (Albolino et al., 2002).

We engaged ourselves in this study prior to system design, because we are persuaded that the design of socio-technical solutions being able to support and empower knowledge management and working performances within an organization is achievable only by studying people practices. The analysed work practices belong to two different organizations: an Italian consultancy firm and a German software-house. Both companies are part of the new economy context and performing knowledge-intensive activities.

The Italian consultancy firm is active, from more than thirty years, in providing professional services to major enterprises and government agencies in the fields of change management, organization, HR, Knowledge Management and Customer Relationship Management. The firm's approach to consultancy is based on working in partnership with the client to build a "tailor made" solution that lasts in time. Therefore, each project requires a specific, in-depth understanding of the clients' organization and needs, aimed at devising specific solutions to maximize effectiveness and quality of working life. The firm employs around 50 consultants and 9 staff, located in Milan and Rome, and has had 50% newcomers in the last two years, mainly young and just graduated from University.

The German software house has developed a complete Digital Asset Management (DAM) solution under a single roof: software development, MSP – Managed Service Provider, Hotline and support and consulting services. The company has been founded in 1992 and it is in a growing phase. It employs 60 people, located in 3 offices within two sites: Hanover and Hamburg. In comparison with the consultancy company, the software house has a more heterogeneous population of workers. Due to the nature of its business, there are:

technicians that are in charge of developing system functionality; supporting staff people that are responsible for system maintenance and user assistance; and, finally, project managers and sales people both working in direct contact with the clients. The latter are responsible for developing new business while the former are in charge of user requirement analysis and of developing the required solutions.

Even if the two organizations work in very different business areas, they seem to be very similar concerning some working practices and knowledge management issues as it will be clear in the following.

Methodology of study

The analysis of communities and their main knowledge management requirements have been conducted through a combination of ethnographic methods and action learning approach, where the focus is on the observation of the working practices and their analysis lead together with involved workers (Barley, 1996). Our approach has been interactive and aimed to activate user participation on system design as well as to build a mutual understanding among observers and observed workers. The field analysis mainly focused on: the identification of the main knowledge exchanges among people (i.e., identification of knowledge networks among experts in different business sectors) (Holland & Leinhardt, 1979; Wellman, 1988); and, the study of the social usage of the physical space (i.e., relations among knowledge exchange and people location). Moreover, during the case study, representations of typical working scenarios (i.e., scenario-based design analysis (Carrol, 1995)) have been used to support our work.

Typical working practices and knowledge circulation patterns

Both organizations are project based and strongly customer oriented. Every employee usually works on different projects, with different customers located in different sites. According to the fast growing business, people spend more time by the client and less in the office. Thus, all the working activities are characterized by knowledge intensive exchanges in highly mobile contexts. The analysis underlines two main levels of knowledge circulation: inside each project and inside the same area of business.

Knowledge sharing inside project teams is based on personal exchanges by emails or telephone calls, this flow is quite fast and effective. However, *as knowledge produced in each project is exchanged in personal conversations there is no track of it in organizational document management systems, neither of the people who acquired it.* Therefore, usually, *knowledge stays in the projects where it has been generated and people participating in different projects cannot access them.* Since people use to exchange information related to their business activities mostly through emails, the huge number of messages is dramatically increasing and the communication flow becomes very hard to manage. In addition, since

servers are not easily accessible from outside the office, people use emails also to exchange working documents (e.g., presentations, new offers, final reports…) and organizational knowledge (e.g., what the company is doing, who is doing what), so *document versioning becomes difficult to manage.*

On the contrary, knowledge circulation within business areas is not very effective; it is mostly based on informal, occasional meetings among people. Unfortunately, people do not meet so often to ensure an effective and complete knowledge sharing. In both organizations people spend a lot of time searching general information and strategic knowledge related to a specific client (e.g., previous projects, contact people, roles, plans, and strategy). It is not only a matter of finding explicit knowledge (Nonaka & Takeuchi, 1995) about that, as documents and formal annotations, but also of knowing who can, among their colleagues, give them the information they need. The analysis reveals that in both organizations usually happen that people work on the development of new methods and tools ignoring that someone else already had work on that. So there is a duplication of efforts to reach the same outcome. *This knowledge is partly present in corporate repositories but it is not linked to daily activities and working practices, so it is not clearly visible to people who need it.* In particular, concerning the consultancy company, the available support for document sharing consists of a mere file system on two servers (one for each site) in which documents are organized hierarchically by client or by project. Project teams are responsible for organizing and managing their own files. Nevertheless, there are not well-established procedures or shared practices for this handling. Thus, *accessing documents is extremely difficult except for people belonging to the project team creating them.* Regarding the software-house company, instead, different systems are in use to support working activities: a document management system as a central repository; a “grass-root” Intranet; various task related systems; a bug-tracking system; internal newsgroups, and MS Exchange Server. All these systems are not integrated and, therefore, also in this case *knowledge is highly fragmented and difficult to access when and where needed.*

According to the project-based activities and to the different physical locations, there are different clusters—based on smaller teams—of people who produce excellence and innovation. These clusters include few people and are focused on specific topics. They can change every time a new project starts or a customer is acquired, or when there is a new service to develop. These networks meet rarely, they mostly communicate through telephone/e-mail to solve a problem or discuss a service development. However, cross-fertilization among different business areas and clusters is not well supported and happens mostly when people move from one project to another or, again, through informal occasional discussions. *There is no track, in the organizational support system, of new knowledge produced within different projects and clusters.*

Typical working day scenarios

To better explain observed working practices, in the following we sketch some typical working day scenarios and main related problems.

Meetings at the customer site. People, above all project managers and consultants, are used to work at the customer site, where they have formal and informal face-to-face meetings to discuss the deployment of projects. Even during business meetings their cellular phones are switched on. Professionals involved in the meeting use remote sources to get fresh inputs to be brought in the discussion; they exchange information and documents with their colleagues in the office through emails and SMSs. Thus, the meeting is not limited to people inside the room. Furthermore, while in a meeting, people are used to monitor other processes to satisfy urgent requests in real time.

Post-meeting communication and circulation of knowledge inside a project. It frequently happens that, after a meeting and while still being at customer site, professionals have a quick conference call with the rest of the project team settled in the office. In this way, the team can use the relevant outcomes of the meeting as soon as possible. Conference participants write down notes on paper and/or on white boards and discuss news about the client. Team members that have not participated to this short conference are individually informed via e-mail – sometimes detailed, sometimes short messages– or by a phone call. Documents in progress are exchanged among team members mostly by e-mail. Only some released documents are stored in the company server. Consequently, *team members cannot have a clear vision of the status of the project.* Therefore, it is likely that some people redo what has already been done or request issues that they will just receive later. *Most of project managers' communications is for putting order in the knowledge shared by the team.*

Moving from one customer to the other: taxi and flight time. When in a mobile situation –the analysis shown– professionals continue working by cellular phone, PDA or laptops. Moving from one customer to the other, knowledge workers have conversations with other team members to receive information about what happened at client site. They also spend time to fix new appointments, update the agenda, look at documents on the laptop, and call customers. Therefore, *professionals need to access and work on the same element or in various related elements in different situations through different media*.

It can also happen to meet colleague while travelling, at the airport for example; in fact, people is used to arrange working meetings within vip rooms to exchange information about projects and company activities. A taxi or a room at the airport can become real offices so as a bar and a restaurant. *These mobile knowledge workers work not in front of their computers. Therefore, traditional PC-centric KM tools are inadequate for their typical working practices. They need enhanced functionalities within their communication tools (mobile telephone, laptop, pda) supporting their strong mobility.*

“Office time”. When people work in the office they meet colleagues who work on different projects and business areas. They exchange a lot of knowledge in an informal way, while making photocopy or while having a cup of coffee. These informal discussions represent a key cross-fertilization manner for knowledge sharing. The con is that it is almost the only way in which these organizations exchange knowledge among different project teams. Moreover, knowledge shared within informal meetings is not recorded in any way on the repositories of the company, and therefore it remains private. In addition, since people in both organizations travel a lot, there are few chances for casual encounters and conversations. Therefore, *the conditions for knowledge exchange are strongly reduced.*

The MILK system

In the previous sections we reported on requirements and problems as emerged from existing studies of community support and from our own observations of the work practices of knowledge workers. Combining this large set of requirements we obtained a more precise definition of what features we want to address in the design of the system, both in the form of functional services and in the modes for accessing these services themselves.

We grouped the gathered requirements in four main categories:

(1) Lowering the cost of participation in the system. This objective is particularly important because the lack of integration between the system supporting community activities and the daily working environment can be a barrier sufficient for preventing participation, on the one hand, and effective circulation of knowledge on the other hand.

(2) Addressing the full spectrum of work situations. This objective is related to the observation that work does not happen in a single standardized way at the desktop. Because of the increased mobility of knowledge workers, occasions for getting benefit from community knowledge or for contributing to it can occur in many different settings; restricting the technology to the desktop can imply a reduced participation with respect to the potential one.

(3) Promoting occasions for informal knowledge exchange. This objective derived from the acknowledgement that informal exchange was already happening, especially face-to-face, however mainly in a fortuitous way, with many difficulties in making the exchanges available to other community members as well.

(4) Increasing the visibility of community activities and of personal contributions. This objective is related to providing tangible rewards by community activities, by making visible the efforts and outcomes produced.

The analysis of these objectives, led us to the design of a system that aimed at being very pervasive on the working environment, in order on the one hand to support users in taking benefit from community generated knowledge while performing daily work, and on the other hand to encourage them to contribute to the community exchanges and to have informal communication exchanges. This translated into the definition of a set of services to support daily and community work activities and into a set of *situated views*. The services to support daily and community activities enlarged typical document sharing functionality to both more knowledge focused and people oriented functionality. The content, its semantics, and its relationships are available in the system, but also the support for contacting and communicating with colleagues when needed and in effective way is provided. It is worth to note that the latter services are the basis for the paradigm shift proposed by Kuhlen (2004). The situated views mapped the most typical work situations—being at the desktop, being mobile, and being in a social space—into ways to present the information that was most appropriate in each situation.

While at the desktop, people tend to be very *task oriented* and focused on *content creation*. That is the best moment in which to provide a context to their work, which draws on knowledge coming from similar activities inside the same community of practice, in order to make reuse and exchange of knowledge possible. This is supported by the provision of contextualized links in the *View with Context.* The desktop is also a possible good vehicle for inputting to colleagues inside the same community of practice, which would be better to make visible very promptly. This has been made possible by another desktop view, called *limbo*, which selectively can expose not definitive content a knowledge worker is working on.

While mobile, people tend to have only limited attention capacity and devices with constrained capabilities. Therefore, they cannot afford a fully participation to communitarian exchange. On the contrary, they need very punctual *notification* and *awareness* of relevant news and the ability to contact people accordingly in a precise way. This is supported by views that push information, the *NewsBroker*, or provide quick access to the searched for information, the *KnowledgeBroker* and the *PeopleFinder*.

While in social spaces, people tend to have informal *content sharing* and have more time to browse into community content. Our objective has been to place interactive boards in which the activities going on in the organization, as inferred from DMS logs of use, are automatically published in order to make visible communities activities. Our approach has similarities with the Babble project (Erickson & Kellogg, 2003) that aims as well at dynamic visualizations of community activity; a major difference with the Babble project is related to a visualization design that is aimed at conveying the information on semi-public large boards. In fact, in MILK the boards are posed in semi-public places (e.g., the

printer room, the entrance hall, the library) to create attractive information points that can be used to see at a glance what is currently going on inside communities of practice and also inside units of work (business processes, projects, task forces, etc.). The latter information is published for promoting spontaneous communication among professionals sharing the same interests and profile, even if their community is not yet been given a public space, i.e. it is still an emerging community. Additionally, these areas posed in different organizational sites are connected by video and audio links. In this way, we aim at recreating a virtual common space where people have the opportunity to meet as if they were in the same physical space. Views are very specific and organized around channels (i.e., *Thematic*, *People*, *News*) that periodically broadcast the information.

The MILK metaphor is providing services through situated views: an integrated solution made of different environments and interfaces, providing information and services using views that are tailored to each of the different work situations. The integrated MILK system infrastructure, to support this metaphor, consists of a heterogeneous distributed multimedia network connecting servers, workstations, mobile devices, interactive and non-interactive screens of various sizes, sensors, etc. It combines wired and wireless communication, including emerging mobile technology, and it has at its heart a common Knowledge Management Engine (KME) which enhances document management services by providing additional knowledge management and communication services to the end user environments: *Office Environment*, *Social Environment* and *Mobile Access Environment*.

Before describing the various services we introduce the *Knowledge Organization* that has been used to structure the information in the system in a way suitable to the various services building on it; it includes information about people and their activities. The organization of this knowledge is centered on a profiling mechanism that associates comparable knowledge descriptions to objects of different nature. The objective is being able to integrate knowledge associated with objects –*elements* in our terminology– that are documents, people, communities and projects comprehensively, in order to compare and contraste elements of any type for computing various kinds of relationships. It should be stressed that artifacts replace the traditional concept of document. An artifact is a compound object collecting various files, each of them being a different representation of the same conceptual content –e.g., the full-text and slide presentation for a paper. This allows the system providing people the most appropriate representation in accord to the activities they are performing and to the specific situation. Moreover, a single representation can have different file formats (e.g., HTML, pdf, ppt for a presentation) and various versions of any representation may also be available.

On the base of this Knowledge Organization, the MILK KME offers the following services to its client instances:

- *Document Management*: MILK is based on BSCW (Bentley et al., 1997), a web-based groupware system using the notion of shared workspaces. A workspace is a repository for private, shared or public information, accessible to members of a *project team* or of a *community*. Distributed co-authoring of documents is possible by keeping track of versions as well as of the changes made by each author. BSCW provides an Event Scheduler that is used to receive event notifications from KME components, queues the events, and deliver them to other interested components. The BSCW Web interface is replaced in MILK by the situated views and only its API to manage content produced in project or community workspaces is used.
- The *Metadata Management System* (MMS) provides facilities to browse search and retrieves items on the basis of the metadata associated to MILK elements. Metadata are organized by profiles that include significant information to identify and classify elements. The MMS includes a service, which monitors the system activity and automatically updates the profiles of elements. It is based on the extended BSCW event service.
- The *Availability Presence and Awareness Service* presents information about people's activities, reachability and availability in order to help users to interact with each other easily and with minimal disruption. MILK presents information about people to the users as an advice and with a confidence measure leaving the decision on if and how to contact someone to the users themselves.
- The *Mobile Access Service* provides access to the KME services adapted to the characteristics of end-user's mobile devices (data communication protocols, hardware facilities, interface restrictions, etc.). All features are tailored for mobile use and adaptable to device capabilities. For instance, opening a document in the mobile environment may retrieve—depending on the device—the abstract of the document instead of the whole document.

Figure 1 shows the overall architecture of MILK. Boxes represent functional components. Interconnections between boxes depict data flow, mostly bi-directional, in the form of Remote Procedure Calls using the XML-RPC protocol.

Desktop View: the Office Environment

MILK on the desktop, see also (Agostini et al., 2003), helps people to manage information and easily access the right sources for creating new contents. Different views over the contents promote awareness and learning that are specific for the current content creation activity the user is undertaking. Such views are tailored to user profiles and activities. Interaction starts with a simple toolbar (compact mode) keeping active a function of general awareness and information advertising (Figure 2). When users start a work session, by logging to the system,

it switches to an expanded mode, which supports—via different interaction mechanisms—browsing, searching for elements, and producing new content.

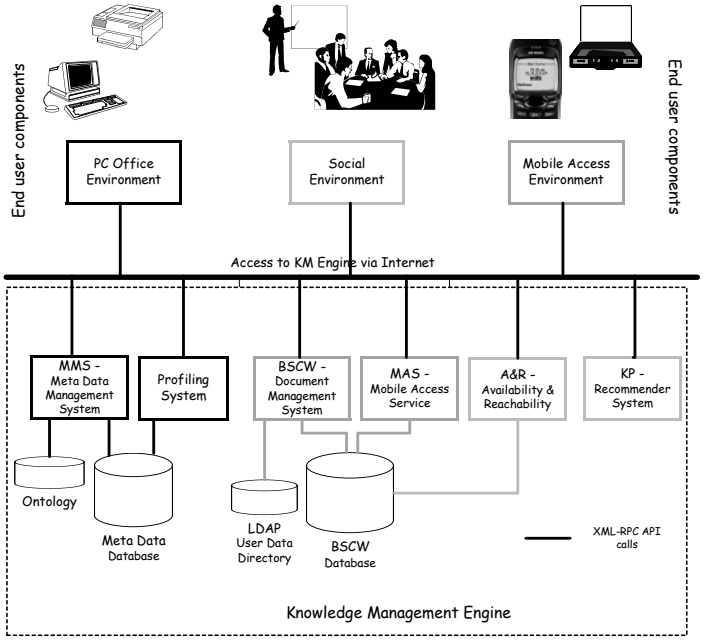

Figure 1. The MILK overall architecture

To facilitate the information discovery, the interaction is centered on the *View with Context* (VwC) panel supplying descriptions of a MILK element (the central panel in Figure 3) along with related elements (the left side panels). The related elements include projects in which the user is involved or on similar topics; documents on subjects that may be of interest to the user; people and communities that share the same interests. The VwC changes the traditional searching approach to information to a more proactive mode in which users receive information that is related to their profile (e.g., expertise, preferences, roles, interests). Just after logging in, the user is supplied by the VwC of his/her personal profile, surrounded by information on elements that are related to that profile. From that presentation the user can navigate the system by setting the focus of the VwC on one of the related elements. Among other things, the VwC facilitates discovering documents without even opening them for verifying the appropriateness, as it is needed in other systems.

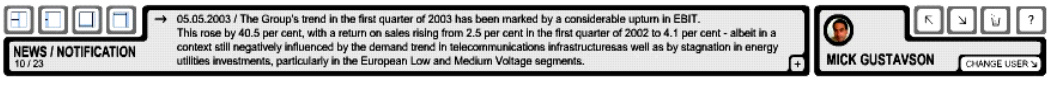

Figure 2. The toolbar in the Office Environment.

Another interaction mode supported by the office environment is through different classifications of elements (the right side panel of Figure 3). Such

classifications can be customized according to the needs of the actual organization. The default classification is the ontology hierarchy, which allows the semantic grouping of the content and supports semantic relations among elements. Moreover, the ontology maps the communities of practice managed by the system. In fact, any node of the ontology hierarchy is, potentially, associated with a community since it represents a key expertise for the organization. By simply clicking on a node it is possible to get a VwC centred on the corresponding community. Actually, the ontology is not static; instead it has to be perceived as a live entity evolving in accord to the evolution of communities as well as of various organizational domains of work. We believe that communities, sub-communities and relationships among them are quite naturally modeled upon the ontology hierarchy. For our involved organizations has been developed a second classification supporting a per-project view; in a similar way it is possible to allow further classifications. This classification includes the organizational structure of those companies that associates activities with projects, every project with a client and every client with an industrial sector. It is worth to note that, a project may be related to various communities depending on the addressed topics; and, vice versa, a community has correlations with all those projects working on the specific interest of that community.

Figure 3. The expanded mode in the Office Environment.

Besides navigation support the office environment offers the opportunity of creating new content by creating new elements. Creating an element means to create a profile and (e.g., for electronic documents) possibly upload a file. Profile creation is supported by the system through the use of the classifications of the right side panel. When a user is filling up a profile form for an element, s/he can include classification information by drug-and-dropping from the ontology, from the organizational structure and from any other classification tree. Moreover, text documents can be automatically processed to extract keywords and key phrases as

candidates for content profiling. Such keywords are then compared to ontology entries to actually define the content profile for the document.

As a special feature, MILK permits a user to create a temporary profile of an "under construction" document facilitating the flow of the information in the company and the mutual support. Such profiles are stored in a special personal area named *limbo*. Profiles stored in the limbo are in between (according to the meaning of the word limbo): they are not truly personal documents of a user, but they are not yet fully part of the MILK system. Remembering that documents are composed of two parts, the profile and the text (or picture, or whatever format), they can be in two states: *visible*, which means that the profile is visible and the text is hidden, and *accessible*, which means that both profile and text are accessible. In the former state the profile of the forming documents is shared among the users of the system to promote awareness and trigger useful collaboration processes. It is worth to stress that the View with Context enables others to see the new document and hence users have the opportunity of discovery synergies and possible collaborations. If a document is accessible, besides reading the profile, users can also read the current version of the associated document.

Mobile view: the Mobile Access Environment

The mobile access components give access to the MILK knowledge from various viewpoints. At the user interface, all views are presented in a portal, which directly accesses to the various views. The most recent and most important news are also directly shown in the MILK portal. As already said, in a mobile situation, the "What's new for me" aspect seems more important than the actual access to the content. Therefore, the *NewsBroker* (Figure 4, left) is the primary view. It actively provides awareness about objects, people and their context and helps the user focus on important actions and information or whom to contact next. It pushes active notifications on MILK elements such as documents, links to the Web, appointments, tasks, discussion forums and annotations both in the context of projects and communities a user belong to.

The *PeopleFinder* (Figure 4, center) handles information about people. It provides awareness about: who is active in the system; who is important in a project or for a community; who is available; and, how people can be reached. To facilitate direct communication between users, the PeopleFinder proposes a list of prioritized communication channels for reaching a person, which depends on the availability and reachability profiles.

Mobile devices are typically constrained by their I/O capabilities and available memory, and by network constraints. For these reasons the mobile environment provides only limited document upload and download functionality. The mobile restrictions on I/O, bandwidth, and connectivity also prevent heavily browsing the system knowledge. Nevertheless, it must be possible to browser folders and projects from time to time. Therefore a simple and lightweight browser, the

KnowledgeBrowser (Figure 4, left), is provided. It allows users to navigate folders and check documents and, if necessary and feasible, download documents or their abstracts or redirect documents to other media, e.g. a nearby fax machine.

Figure 4. NewsBroker, PeopleFinder, and KnowledgeBrowser views.

Social view: the Social Environment

The way to support the social view has been based on placing interactive boards where the activities going on in the organization—as inferred from DMS logs of use—are automatically published in order to make visible communities activities. The boards are in semi-public places like the printer room, the library, etc. Figure 5 shows one user site installation of MILK, where a leisure area with magazines is augmented with an interactive large screen. Our objective is to create attractive information points that can be used to see at a glance what is currently going on inside communities of practice and also inside units of work (business processes, projects, task forces, etc.). The latter information is published as well in order to promote the spontaneous communication among professionals sharing the same interests and profile, even if their community is not yet been given a public space, i.e. it is still an emerging community. Additionally, these information points are connected by video and audio links. In this way we aim at recreating a virtual common space where people have the opportunity to meet as if they were in the same physical space. The design idea that we had was of an attractive broadcasting space that could support communication whenever needed, e.g., when some information found on the screen triggers the need to know more from the author, or when we want or need to talk to other people who are reading news on the other site.

The public displays, based on what we have defined as a *broadcast* model, work as information pushing devices when nobody is interacting with them, mixing the different channels. As soon as somebody starts interacting with the

system it switches to pull mode, and the user gets access to any information s/he needs. The broadcasting mode in the social environment is designed to give both hints of what's going on inside the company to non-interacting onlookers, and to urge them to start interacting with the screen (switching then to pull mode), to go deeper inside the items they find more relevant, or to browse by organizational theme exploring the system content. The alternation between the channels in the broadcasting mode depends on a set of rules based on time of the day and users' activities, controlled and modified by the system administrator to push certain kinds of data and promote specific information to all fellow workers. As mentioned before, information to be broadcast has been clustered in channels. Each channel represents a specific view on the knowledge present in the organization and is relevant for different communities.

Figure 5. One of the site installations

The Thematic channel (Figure 6) is the channel providing information about current units of work, i.e., projects and community forums. It is the channel from where new and interesting information can be accessed, read, bookmarked, and also enriched with comments and personal notes. Moreover, using this channel it is possible to access information across different sites in support of synchronous video contacts. In order to retrieve its content, it monitors the activity in the DMS and prioritizes it for providing only live information. It utilizes some layout rules in order to represent activity parameters:

- Colour: membership of an organizational area of activity.
- Distance from the centre and colour fading: the overall amount of recent activity.
- Size: overall amount of activity.
- Thickness: degree of novelty.
- Shape: to differentiate among projects (circle) and communities (wheel).

The People channel (Figure 7) is the channel providing information about people in the organization, their current location and availability, and the means to contact each person. The channel dynamically updates the information about the

current location of the users. The granularity of the information is kept at the level of the different organizational locations or not being in the office. The system integrates functionality from an availability service that can also register at each moment the preferred channels for interactions (e.g., SMS while attending a meeting).

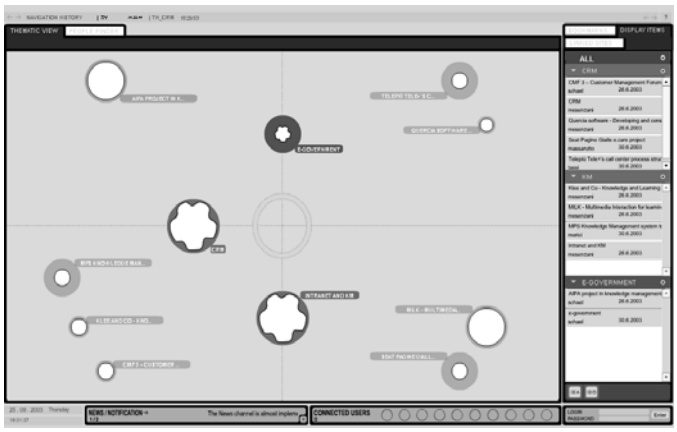

Figure 6. The Thematic channel.

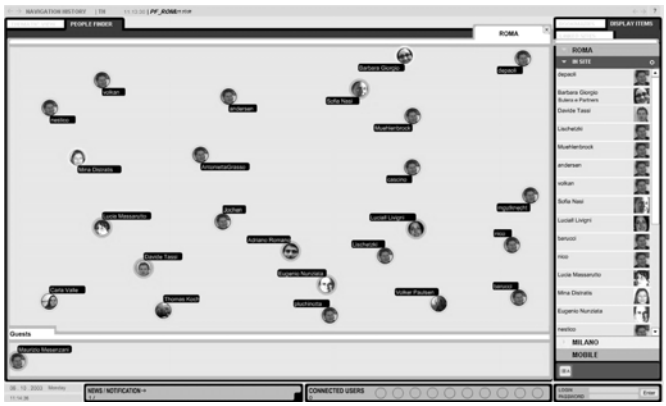

Figure 7. The People channel.

A number of layout rules are used in order to facilitate quick overview:

- Location tabs: each tab represents a site showing the people who have that reference location.
- Colours: identify a location; people currently detected in a location are represented with the colour of the site where they are.
- Guest area: people visiting the site.
- Grey Colour: mobile people.

The News channel (Figure 8) is used to broadcast information that the organisation wants to transmit to everyone on a site or across all sites. The news has its own channel, but is also overlaid to whatever current channel is displayed

if no one is interacting with the screen. It is displayed using a style borrowed from newspapers and is meant to attract attention even from afar.

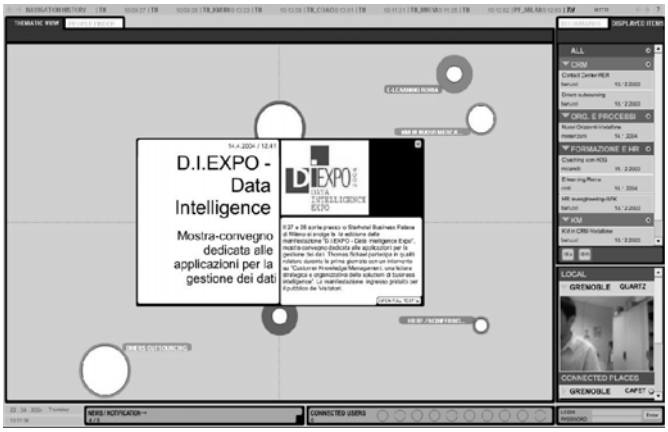

Figure 8. The News channel (overlaid).

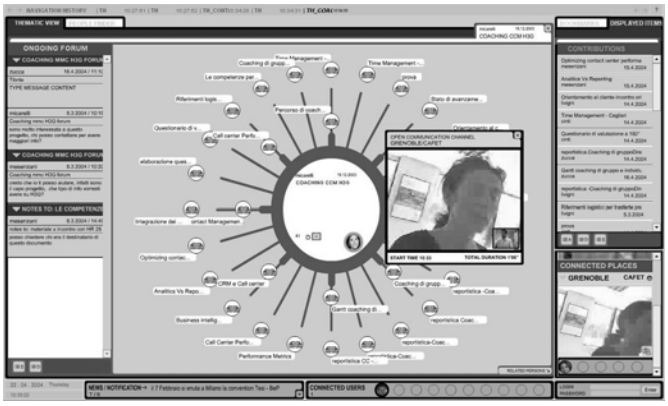

Figure 9. The Video channel (bottom right and overlaid windows).

The Video channel (Figure 9) is a channel devoted to support synchronous communication. It provides the visualization of the connected sites and supports the possibility of unplanned video-audio sessions. It also includes some light support for collaboration, i.e. it is possible to share content on the fly across the various sites in order to support the discussion.

Conclusion

In an already cited report comparing existing systems in support of communities, Wenger (2001) identified a number of dimensions that are relevant in order to successfully support community life and development. These dimensions include the easiness and broad spectrum of participation, the provision of value in return to the contributions, the visibility of community activity, the support of different

levels of membership, the openness to the external world, and the support for evolving phases of the community life. If those are compared to the design principles that guided the design of the MILK system, which are the integration of the community support functionality with the daily work environment and the development of situated views mapping different work situations, we can see that the MILK approach provides a contribution to the most relevant of the dimensions identified by Wenger. He acknowledges that the participation in the community life is in competition with all the other activities a member is part of, primarily the work tasks of the ongoing projects. Therefore participation must be easy, in order to reduce possible barriers and lower this tensions in priorities. In MILK we suggest that participation not only must be easy, but also fully integrated with the daily work environment, so to lower not only the learning curve of the community system, but also to smoothly move knowledge from the projects to the communities and vice versa as opportunities for exchange occur. This is also complaint with the other requirements from Wenger of providing a clear value in return to the community participation and activities. MILK also addresses the visibility of community activity, the support of different levels of membership, and the openness to the external world, by enlarging the visibility of communitarian activity to social areas in the organization, where abstract representations of their activities are provided. Finally, regarding the dimensions identified by Wenger, the support for evolution of the community is addressed only in an implicit way by MILK. In fact, the metadata capturing the activities in the system guide the selection of content in some views according to the freshness and likeness of exchange.

Matching our own set of requirements to this set that has been derived by long observation of community life and activities has provided us with a further confirmation that the design approach of MILK is sound. The future work is validating its design and how effectively it affects these dimensions will consist of fieldwork observing its usage in the context of our user organizations. This will be the main task of our future activities related to the MILK system.

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