Social Software Beyond the Desktop – Ambient Awareness and Ubiquitous Activity Streaming

Florian Ott, Michael Koch, Bundeswehr University Munich, Neubiberg

Summary
Our daily work in the information society relies on creating, editing and collecting different information objects. Without additional presentation mechanisms these activities of particular knowledge workers remain hidden in the underlying IT systems. The resulting lack of awareness can lead to inefficient coordination as well as to the duplication of work in the worst case. Activity streams from Social Software offer new ways to increase the awareness, but the desktop-based user interfaces in typical organizational settings currently only utilize a small portion of their full socio-technical potential. In this paper we present CommunityMirrors as one potential solution to this problem.

Keywords
H.5.2 [Information Systems: Information Interfaces and Presentation: User Interfaces]; H.3 [Information Systems: Information Storage and Retrieval]; Social Software, Awareness, Activity Streams, Ubiquitous Natural User Interfaces, CommunityMirrors

1 Introduction
More than ever our daily work in the information society relies on creating, searching and combining information objects like documents, emails or similar digital content.

1.1 Availability and Visibility of Information
While in the recent past, time and location independent access to information were main challenges (e.g. [1]), the general availability of information is not a problem anymore. Information is available in the Internet and in many different data repositories in the organizational context.

Due to the ongoing growth of the information pool, one main challenge for efficient knowledge work is finding individually relevant content. In the different enterprise data silos pieces of information are not sufficiently visible until they are pro-actively viewed or retrieved.
Many tasks in knowledge work require coordination with other people, which makes awareness about the work of others very important. In current IT systems, however, still most of the interactions with information objects (like edits, comments or other refinements) are hidden away from the eyes of (other) knowledge workers.

1.2 Social Media and User Generated Content
The Web 2.0 has meanwhile arrived in organizations [2]. Internal Social Networking Services (SNS), microblogging platforms or enterprise wikis have successfully implemented the paradigms known from the Internet at the workplace. Enterprise Social Software increases the possibility to participate which leads to more user generated content. Compared to former cooperation systems Social Software has one main difference: it seriously focuses on human activities around information objects and visualizes them in a person-centric context instead of "only" supporting the digital storage and retrieval of insulated data entities [3].

This leads to the following two impacts on the problem of missing visibility of enterprise information: 1. With the use of Social Software activities of other people become more present and visible in IT systems. 2. Content is not only anonymous "data" anymore, but becomes visibly interconnected to the people involved in its creation and refinements.

More than ancient "knowledge management systems" Social Software supports knowledge workers by offering person-centric communication, coordination and cooperation services [4]. By making individual activities more visual for other people it contributes to transparency and awareness as well as to the appreciation many knowledge worker expect for their "participation" [2].

1.3 Missing Social Interfaces for Social Software
Most of the daily knowledge work typically still takes place at single user desktop workplaces, only with a PC and without direct inter-human interaction.

Desktop workplaces with their physical restrictions currently constrain the development of the full potential of the "social" software paradigm. There are many situations during a typical knowledge workers’ day where additional information about the activities of others could be helpful beyond the own desktop. These range from ubiquitous "discovery" situations (e.g. becoming aware that someone has uploaded a new presentation on an interesting topic while walking to the cafeteria) over ubiquitous scenarios supporting individual motivation (e.g. seeing positive comments on own activities while waiting for the elevator) to real ubiquitous collaboration processes (e.g. using information in synchronous team meetings). Exactly these (by definition) "social" use cases for interacting with activity streams still lack respective user interfaces that allow semi-public multi-user interaction beyond desktops and personal mobile devices.

1.4 New User Interface Hardware and the Blank Screen Phenomenon
With the availability of portable and mobile devices we have meanwhile arrived in the era of ubiquitous computing like proposed by Mark Weiser thirty years ago [5]. Different new user interfaces – first and foremost mobiles and tablets – have found their way into organizational settings. Based on the steadily falling prices of LCD hardware [6] many companies have acquired large, partly interactive screens. These are typically installed at various semi-public places like lobbies, coffee corners or conference rooms within companies. In contrast to mobile and tablet devices, the stationary multitouch systems are currently rather used as gadgets than being deployed for helpful business scenarios. In most of the cases the devices are either turned off or show some static presentation. The potential of using these (touch) screens for real business objectives so remains unexploited [7].

To summarize the so far described developments see: 1. Different data-centric enterprise information systems storing valuable information objects without making them visible to knowledge workers and without directly interconnecting them. 2. Social Software making activities of knowledge workers around different information objects more visible in form of person-centric activity streams. 3. A demand for more "social" user interfaces beyond classic desktop workplaces supporting ad-hoc information discovery and knowledge sharing in more social settings. 4. The general availability of new (multitouch) hardware at different semi-public places in organizations, but without use cases to support business objectives ("blank screen phenomenon").

2 Potentials of Ubiquitous Activity Streams Beyond Desktops
Based on the developments described in the previous section we have created the idea of "CommunityMirrors™" as large interactive screens extending the benefits of Social Software for knowledge work beyond the physical barriers of single user desktops. CommunityMirrors are peripherally recognizable "information radiators" [8] that show "info particles" from existing enterprise IT systems. The

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1 Although individual activities have already been considered an important influencing factor for workspace awareness in earlier CSCW research (e.g. [31]), real Activity Streams have not been present until the recent success of Social Software.

2 Of course, links to people have already been available e.g. as file attributes in classic data-centric IT systems / groupware (e.g. [34]), but there has not been any dedicated focus on people in form of activity streams or similar.

3 Because of the direct interaction without mediating devices that allows "walk-up-and-use" without any learning phase these new devices are often called "Natural User Interfaces" (NUI) compared to Graphical User Interfaces (GUI) or Command Line Interfaces (CLI); see e.g. [35].
screens can be installed in different semi-public places, like e.g. beside the elevator, in the coffee corner or other social areas where people come together.

As amendments to classic desktops (not replacements!) the interfaces can help to create visibility about what is going on in the organization (awareness) and facilitate the “accidental” discovery of relevant information without having to explicitly look for it (serendipity). The re-integration of information objects into their social surrounding enables people to directly talk about the discovered information without computer mediation. Thereby, the additional interfaces can help to efficiently generate a better “common ground” [9] for successful collaboration.

In this section we present some general potentials of CommunityMirrors for Social Software. These success factors have been collected in evaluations of CommunityMirror prototypes over the last three years in different organization settings by observations and user feedback (e.g. [10–13]).

2.1 Information out-of-the-box and Serendipity

Based on the four assumptions stated in the introduction, the principle of success for all following concepts is to take the following three things “out-of-the-box”:

1. Information objects out of the different “hidden” data silos where they are stored.
2. Knowledge workers out of their restricted desktop-based working environment.
3. Interconnections between the virtual world of (1) and the real world of (2) out of activity streams from Social Software.

In general, this means first of all opening up the different data silos and taking existing valuable information objects out of their “box” as shown in Fig. 1.

The next step is to use personal profiles of “natural” human beings as well as user-generated folksonomies (e.g. from Social Software) as linking elements between the different information objects. In contrast to data-centric approaches known e.g. from the Semantic Web, this has the benefit that these profiles have a physical real-life representation. They can be used for better interconnecting the virtual and the real “knowledge space” and thereby contribute to better socio-technical integration of the digital information objects into their corporate surroundings as shown in Fig. 2.

Of course the interlinking itself is not sufficient to generate the desired awareness for knowledge workers about what is happening in the enterprise information space. Therefore, the generated “knowledge graphs” from Fig. 2 need to be presented somehow. To avoid distraction from desktop work on the one hand, and to simultaneously generate meaningful use cases for the often already existing hardware this can happen on additional large semi-public interfaces where people can come together and jointly browse in the information space as pictured in Fig. 3.

In a nutshell this is what we call the “out-of-the-box” effect. Of course this cannot be done for all kind of data sources in equal manner. The approach can be especially helpful for information objects that are not searched deliberately, but profit a lot from being displayed and consumed peripherally, like e.g. activity streams and other awareness information. The overall concept of the out-of-the-box effect is also known as “serendipity” [14;15], which in general means finding information accidentally without having to look for it explicitly.

2.2 Inter-human Communication and Social Knowledge Sharing

Another challenge within the IT support for knowledge intensive collaboration processes is the non-sufficient socio-technical integration. Knowledge sharing is a social process in which people share information in networks and communities. IT support currently causes original
inter-human communication to be artificially digitalized by using computer systems. This is exactly what many organizations are facing with community platforms and SNS at the moment: instead of walking to the next office and talking to each other (which can be a very efficient process for knowledge sharing and the generation of new ideas [16]), even office neighbors tend to use digital communication [17].

From this perspective the following things are important for the socio-technical integration of collaborative knowledge processes:

1. **Open physical spaces** where people can come together and talk to each other willing to share their individual knowledge.
2. **Semi-public user interfaces** in these natural open collaboration spaces facilitating the access to relevant enterprise data sources.
3. **Visualizations** linking the virtual and the (real) physical world and allow “ice breaking” between people standing in front of the screens to motivate them for ad-hoc knowledge sharing.
4. **New interaction paradigms** that enable real “social” multi-user interactions for joint information discovery and joyful collaborative browsing in information spaces.

Figure 4 summarizes these key success factors in form of a schematic overview with the integrated data sources of the left, the additional ubiquitous user interfaces as linking element between computers and humans in the middle as well as the real-life networks where the inter-human communication and knowledge sharing take place on the right.

### 2.3 Information Radiators for Appreciation and Motivation

The concept of awareness as “an understanding of the activities of others, which provides a context for your own activities” [18] is meanwhile widely spread in cooperation systems. Increased awareness facilitates the digital supported establishment of a “common ground” [9] that is necessary for meaningful conversations and relationships. Thereby, awareness information is one important prerequisite for successful collaborative knowledge processes (e.g. [16;19;20]). The value of awareness can be seen in lowering coordination costs by enabling implicit coordination, and in supporting different forms of intrinsic motivation [21]. This “appreciation through awareness” is especially important for knowledge work as the incitement of many people relies on their contribution being seen and recognized.

By the extension of Social Software interfaces beyond the desktop this potential can be extended to social situations allowing not only individuals to separately consume awareness information, but also groups of people to jointly watch and talk about activities of others. This in turn can help to foster “mutual knowledge” [22;23] through “consequential communication”.

Awareness information with their rather short half-life period profit a lot from being consumable peripherally, e.g. while walking from one office to another or while standing around talking with others during the coffee break. Based on this proactive distribution of awareness information as “info particles” we also speak of CommunityMirrors as “information radiators”. The term “information radiator” has first been coined by Cockburn for frequently updated posters showing the current state in software development processes in a high traffic hallway. The radiators provide pieces of information or in other words concrete visual representations of information objects stored in the underlying data sources in a way that makes them consumable peripherally. In contrast to most other IT systems which only “provide” information after a certain user interaction (e.g. a search) information radiators proactively distribute their “info particles” independently from any user in order to generate appreciation for the contributors and thereby motivate them for further participation and sharing.

### 3 CommunityMirrors for Social Software

The name “CommunityMirrors” reflects the fact that the ubiquitous interface “mirrors” virtual activities of IT systems in physical spaces and thereby blends between digital and non-digital contexts. The core principle of CommunityMirrors is the re-use of existing enterprise information systems without generating another data silo. Their most important “use case” is the proactive distribution of existing information objects as omni-present info particles in semi-public spaces like e.g. hallways or in social areas. CommunityMirrors give employees the chance to recognize valuable information while passing by (e.g. on their way to their desk in the morning, during the coffee break, or while waiting for the elevator). If someone has been attracted by individually relevant

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4 In addition to explicit communication, people also pick up considerable information that is unintentionally ‘given off’ by others as they go about their activities. This is called consequential communication [\ldots].” [36], p. 99.

5 Cockburn described an information radiator simply as “information in a place where passersby can see it.” [37], p. 114.
information, he can directly use the touch-based interface to dive deeper into the information space. Further information about CommunityMirrors can be found e.g. in [10–13; 24; 25]).

CommunityMirrors are based on the co-called CommunityMirror Framework (CMF), a flexible toolkit that helps to create specific CommunityMirror applications for different deployment scenarios. The concept has been implemented in various settings during the last three years (e.g. [26; 27]) and is currently been introduced in a large company.

All of the potentials and requirements described before have their origin in observations from these settings. Already conducted evaluations have confirmed that the additional interfaces can indeed help to improve the awareness and participation in the respective communities (e.g. [28]).

In the following section we will focus on recent changes of the CMF that help to provide ambient awareness and ubiquitous activity streaming for Social Software beyond classic desktop workplaces.

3.1 CommunityMashup as new Technical Foundation

While integrating different Social Software tools we discovered that the existing interfaces of the CMF would not be sufficient to fulfill the requirements described in Sects. 1 and 2. Although CommunityMirrors were already able to import information from databases, CSV or XML files and RSS feeds as well as Twitter and certain enterprise wikis, most of the currently established Social Software in organizational contexts uses own API mechanisms as interfaces. Furthermore, the interlinking between social profiles and other existing enterprise data sources was not easily possible with the existing integration mechanisms.

To gain more flexibility and include additional aggregation, unification and filtering options for the different enterprise data sources we developed the CommunityMashup, a flexible person-centric data mashup based on a model-driven development approach [29; 30]. The CommunityMashup as new technical foundation of CommunityMirrors provides the following benefits for Social Software beyond desktops:

1. Unified access from stationary as well as from mobile clients to person-centric activity streams that have been aggregated from different data sources.
2. Automatic interconnection of different info particles based on tagging/folksonomies.
3. High-level API with different search and filtering functions.
4. Additional caching for offline deployments.
5. Flexible semi-automatic reactions to frequent API changes in the source systems based on the used model-driven development approach.

By integrating the CommunityMashup with the CMF in the course of deploying interfaces for Social Software beyond the desktop the CommunityMirror concept has become even more lightweight and flexible as it was before.

3.2 From Awareness to Engagement and Collaboration

Based on our observations we developed a social interaction model for ubiquitous Natural User Interfaces in organizational contexts, which is visualized in Fig. 6. The theory of the interaction zones is mainly derived from [31; 32] and was adapted to the given context. Beside a semi-public Interaction Zone as well as potentially available Private Zones we identified three interesting areas:

1. The Communication Zone, in which users actively monitor other people or talk to them while interacting with the system.
2. The Notification Zone, in which users’ attention can quickly be caught by certain attractors on the screen.
3. The Ambient Zone, which mainly supports the submission of peripherally recognizable awareness information (“information radiation”).

The different zones distinguish themselves especially by different levels of attention the respective users pay to the application. This can be visualized with regard to the view direction of the corresponding users as shown in Fig. 7.
With the use of Social Software as additional data source for CommunityMirrors we are confronted with another level of intensity: the intensity of the user interaction with the Activity Stream. In Social Networks there are typically certain power users with a very strong presence that frequently comment on posts (dominators). In contrast to that, there are many users that do not interact at all and just watch what is happening in the stream (observers). This spectrum is also valid for semi-public interaction with Social Software beyond the desktop. Based on our evaluations we differentiate the following interaction levels beside the ground level “(0) Not Involved”:

1. **Awareness**: The first level; users of this level are in most cases just passing by in the ambient or notification zone in Fig. 6. This level is also very present in the communication zone. Here even twice, once as awareness of what is shown on the screen and once as awareness of what other users are talking about while using the system. Users that have reached this first level can be attracted very easily to “higher” interaction levels when they see something they are interested in personally.

2. **Discovery**: The second interaction level is reached as soon as a user becomes somehow active in the interaction zone of Fig. 6, e.g., he wants to display more details about a seen info particle. The typical behavior in this level is browsing around for a while in the information space. The duration of this discovery phase depends very much on whether the users can easily find more information that he is personally interested in as well as of his personal involvement in the information he sees.

3. **Engagement**: This third level is very specific for Social Software and depends much on the personal identification of the user with the content he has discovered. Depending on the individual involvement he will show his appreciation for some of the displayed info particles. The best-known mechanism Social Software offers for that is the Like-Button known from Facebook. But also other engagement mechanisms like e.g. a star rankings are accepted.

4. **Collaboration**: This last and highest interaction level is reached as soon as a user decides not only to consume information or engage for it, but to really contribute to the joint information space. The easiest way of doing that is leaving a comment to a certain info particle.

With the use of CommunityMirrors for Social Software especially engagement and simple ways of collaboration become more important. By implementing these mechanisms in the user interface and especially by transferring the results back to the source systems CommunityMirrors can help to foster participation and generate more appreciation for contributors. One main challenge for the interaction levels 3 and 4 is the required identification of the respective user. This is quite simple in single-user desktop scenarios, but at least somehow challenging in the semi-public multi-user touchscreen setting. Here, the input of username and password while user users are watching is definitely not desirable. We are currently experimenting with different technical approaches together with industry partners to find better solutions for identification as well as for authentication. Methods under investigation range from RFID detection over capacitive barcode stickers to face detection as well as combinations of the different methods for different interaction levels.

### 4 Conclusion and Future Visions

CommunityMirrors as ubiquitous Natural User Interfaces have evolved over the last years from simple research prototypes that have been built for specific evaluation purposes and have been restricted to certain sets of data sources to universally deployable interfaces for Social Software beyond the desktop. One of the most important steps in this development process was the replacement of the so-far used internal data model in the CMF by the recently developed CommunityMashup, a flexible and person-centric data integration solution. With the use of the CommunityMashup different data sources can be aggregated, filtered and provided as a unified person-centric activity stream that can help to support knowledge-intensive collaboration processes by increasing awareness and appreciation.

![Figure 7](image-url) View directions of the different users in the social surrounding.

![Figure 8](image-url) Quo vadis – Natural Open Collaboration Spaces (NOCS).
We are currently working with different designers and industry partners to create more adequate multi-user visualizations and interaction paradigms that especially fit for peripherally recognizable activity streams. In addition to that we are also working with architects on the better integration of the interface hardware into the organizational context.

By that, we hope to support a transition for the corporate collaboration space in general. Instead of keeping the existing often not sufficiently frequented aseptic conference rooms that many organizations currently have, we propose to use this space for building Natural Open Collaboration Spaces (NOCS) like shown in Fig. 8. In these NOCS people can come together for socializing and networking as well as for other joint activities, like e.g. brainstorming or simply for talking around a cup of coffee. Simultaneously to all of these activities the knowledge workers can collaboratively browse through the information space by using different CommunityMirror installations.

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Received: May 15, 2012

Florian Ott is researcher at the Cooperation Sys-
tems Center Munich (CSCM) and technical lead
of the CommunityMirrors project. After having
graduated in Computer Science and Business
Management in a parallel double major, his re-
search focuses on new multitouch multi-user in-
teraction paradigms for wall-sized screens as well
as the suitability of these technologies for building
socio-technically integrated ubiquitous Natural
User Interfaces for Social Software.

Address: Universität der Bundeswehr München,
Fakultät für Informatik, Werner-Heisenberg-Weg 39, D-85577 Neubiberg,
e-mail: florian.ott@unibw.de

Prof. Dr. Michael Koch is full professor for ap-
plied informatics at Bundeswehr University Mu-
 nich where he is leading the Cooperation Systems
Center Munich (CSCM). His work is about shap-
ing cooperation systems, i.e. bringing collabora-
tion technology to use in teams, communities and
networks. He is member of the boards of the spe-
cial interest areas on Human Computer Interac-
tion and Information Systems in the Gesellschaft
für Informatik (GI).

Address: Universität der Bundeswehr München,
Fakultät für Informatik, Werner-Heisenberg-Weg 39, D-85577 Neubiberg,
e-mail: michael.koch@unibw.de

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