Supporting Creative Collaboration in Globally Distributed Companies

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ABSTRACT

Creative ways of working with whiteboards and sticky notes are growing in popularity even in global companies. However, digital tools for enabling these ways of working, especially for geographically distributed teams, have still not been adopted in these companies. We present Tele-Board, a web-based digital whiteboard and sticky note system and describe how it was used in a large company at three locations. From system log data and interviews recorded after three months of use, we found that idea generation and feedback collection can be facilitated if a system offers real-time synchronous editing as well as asynchronous input. Interestingly, the users who were *not* located at the company's headquarters regarded the tool as very beneficial and used it more than their colleagues at the headquarters. We provide a detailed analysis of the study and important points for fostering the adoption of creative tools in large companies.

Author Keywords

distributed teams; remote collaboration; global work; professional communication; idea generation

ACM Classification Keywords

H.5.3. Group and Organization Interfaces: Synchronous interaction, Asynchronous interaction, Computer-supported cooperative work

INTRODUCTION

Collaborative work over geographic distances is common practice for most employees of large global enterprises [20]. Many meetings include participants from multiple locations worldwide [6, 14]. Although a variety of tools for supporting different working modes exist, the most commonly used tools are still audio conferences (for synchronous communication) and e-mail (for asynchronous communication) because they are readily available and easy to use [22, 32].

Still, some ways of working, such as collaborative brainstorming or sketching ideas on a whiteboard, cannot be completely supported in remote situations using standard tools.

But this way of working is becoming more and more prevalent. It is even seen in larger companies who seek to introduce methods such as design thinking [2] in order to increase their innovative potential [21]. Though whiteboard and brainstorming applications have been developed and researched for decades (e.g. [17, 19, 25, 33]), they have not been widely adopted in larger companies [15]. It was our goal to investigate whether and how this situation could be changed.

We developed Tele-Board, a digital whiteboard and sticky note software system. It supports design thinking over geographic distances and aims to improve the communication and collaboration for globally distributed teams [9]. In order to determine how well it suits the needs of a corporate environment, we deployed our system at three locations of a large IT company. The study lasted three months.

In this paper, we present our findings on how team members at the different locations used Tele-Board and the benefits they saw in using it for their daily work. Though we thought the team would mainly use the system for synchronous remote meetings, they often used it asynchronously as well. By working asynchronously, they could prepare meetings in advance, enter feedback whenever they liked, and bridge time zones. Contrary to our expectations, we found that users at the company's subsidiaries used the system more frequently than those users at the headquarters. Furthermore, they found that the tool could save them time. The team in this study did not use any digital whiteboard hardware. This was due to organizational and economic reasons. Still, they appreciated our whiteboard and sticky note system for idea generation and feedback sessions, even on their standard computers.

RELATED WORK

In order to support working modes such as design thinking [2], we had been looking for tools that offered the possibility of writing or scribbling on a whiteboard. This included sticky notes or similar objects. An additional requirement was that it be possible to work at different locations simultaneously with the interactions synchronized at some point. During this collaborative work an awareness of the remote partner, as described by Gutwin & Greenberg [10], must be preserved.

There is a large body of research on digital whiteboard applications, but these applications often focus only on co-located use, e.g. [13, 24, 25, 26] or do not offer sticky notes or similar tools that provide the possibility to add ideas and information [12, 17, 30, 31, 33]. A good example of a system that combines these two attributes – remote collaboration and

sticky notes – is the *Designer's Outpost* from Klemmer et al. [19]. In this system, users can work with physical sticky notes that are captured by a special camera setup and digitized. In the *Distributed Designer's Outpost* from Everitt et al. [7] the system was augmented with shadows that made it possible to see remote people standing at a digital whiteboard. However, we consider the digitization of paper sticky notes as too slow and cumbersome. Additionally, inconsistency problems arise when the digital version of a sticky note is moved and the paper version stays in its place.

We see *Clearboard* [17] as a good model for our system regarding two crucial points: conveying workspace awareness [10] and connecting a remote video image with the content on a whiteboard. Clearboard provides a "reference space" [4] for pointing and gesturing in order to improve communication and uses real video and not only shadows as *VideoWhiteboard* [33] or *Distributed Designer's Outpost* [7]. The main drawback of *Clearboard* is the missing functionality of manipulating the other person's drawings and any other artifacts they created. We believe this functionality is very important for distributed collaboration.

Neither these systems nor any comparable ones are in use in companies today. In the early nineties, the *DOLPHIN* groupware application was introduced for meetings in corporate environments [29]. It was designed for co-located use but could also connect with remote users or meeting rooms and offered several whiteboard functions and the possibility to create notes. The system had all functions that are important for creative meetings over distances, but its use has been discontinued.

Global companies that apply Design Thinking today, such as Procter & Gamble, use a TelePresence video conference system [1]. This system conveys the feeling of sitting around a table together. However, this solution is not available to the majority of the teams because dedicated TelePresence rooms entail a great deal of expensive equipment. Additionally, there is still no common creative workspace between the subsidiaries of a company for sharing artifacts similar to traditional whiteboards and sticky notes.

In order to share artifacts, people in corporate environments mainly use file sharing and desktop sharing systems for their meeting related content [27, 34]. But these systems allow editing to only one user at a time. Others can contribute only via audio or must wait their editing turn. With this "one at a time" mode, distributed and reciprocal synchronous collaboration is not possible. Even though research has proven that real-time and synchronous connectivity is important for successful collaboration [26, 28], standard meetings in large companies still rely on the tools described above. In their research, Yankelovich et al. proposed the *Meeting Central* prototype for improving the effectiveness of distributed meetings [34]. However, the available applications remain similar to the existing tools. For example, the desktop sharing application still only gives one user the possibility to "take control".

Other research on collaboration in corporate environments has mainly focused on social software such as blogs and so-cial networking sites (e.g. Muller et al. [23] give an overview of different tools) or social file sharing in an enterprise [27].

A particularly big problem for the adoption of digital whiteboard systems is the special setup required. Such a setup is not easy to implement in large companies where meeting rooms are always changing [15]. Additionally, in a lot of meetings, people have a variety of different professional backgrounds and do not have time to learn how to use new tools [6]. The lack of time on the part of participants means that even if new tools may benefit users, they do not easily find their way into most companies [22].

Although we designed Tele-Board to be used with digital whiteboard hardware, and ideally with an integrated video-conferencing for deictic references [9], it was very important to us that it could be used with normal computers as well. In the following section, we introduce Tele-Board and the Tele-Board features that were most relevant for the team of our study.

TELE-BOARD

Tele-Board is a tool that supports creative teamwork, such as design thinking, even if team members are located at different locations. As it is our main objective to support distributed teams, all actions that take place at one whiteboard instance are automatically transferred to all other connected whiteboards that show the same content. Sticky notes can be created directly at a digital whiteboard or with a variety of other devices, as for example, a smartphone, a digital pen, or a laptop. All users can create sticky notes at the same time in order to enable parallel work and prevent "production blocking" [16, 26, 28].
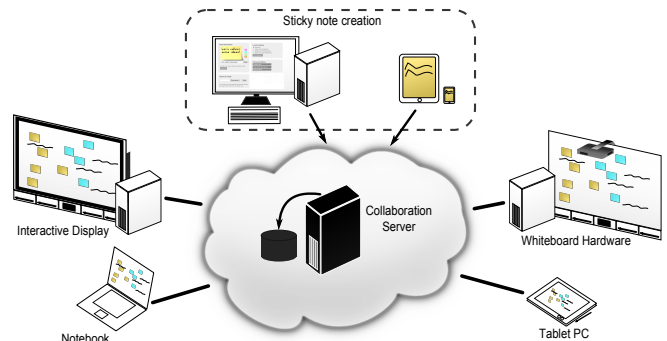

Figure 1. The Tele-Board software system architecture. All connected devices are synchronized via the central collaboration server. The whiteboard client software can run on a variety of hardware devices. These are displayed next to the server component. Sticky notes can be created with the help of mobile devices acting as digital sticky note pads (e.g. tablets or smartphones) or in the Web portal.

The components of the Tele-Board software system are the *Web portal*, *whiteboard client*, *digital sticky note pads*, and *server component*, which run on a variety of hardware devices (for an example see Figure 1). Originally, we thought that teams would want to use Tele-Board at large displays with touch and pen input options, in order to recreate the experience of working at a traditional whiteboard. But we learned that employees at large companies could not imagine having a dedicated meeting room with interactive whiteboard

hardware. For them, it was essential to use a whiteboard application on their standard computers as well. Therefore, we made sure that our system ran on every computer and did not require any special installation or setup.

Web Portal

In the Tele-Board Web portal, users can manage *projects* and *panels* in order to organize their work and control access rights. Only users who are assigned to a project by a project administrator can see it in their list. Working inside a project, users can create various panels that represent virtual whiteboard spaces.
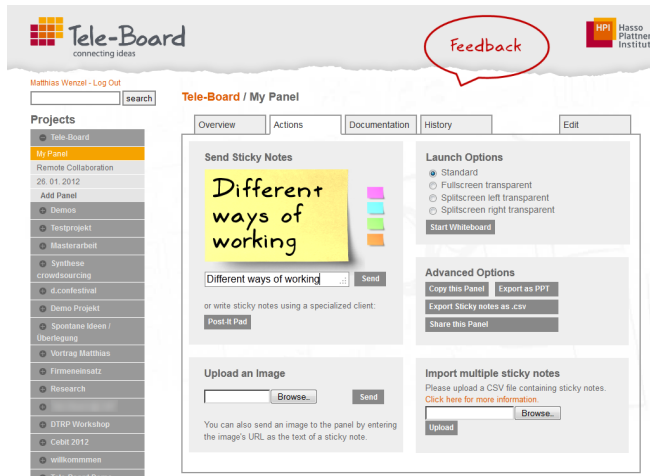

Figure 2. The Tele-Board Web portal (demo system). The left menu shows all projects and panels the user is assigned to. Every panel has different tab views: on the Overview Tab a feed of recent activities is shown, on the Actions Tab the user can write sticky notes, upload picture and access export functions.

Each project and each panel has its own *activity feed* on the *overview tab*. Here, one can see who worked on a project or panel at what time and read or write comments. On the overview tab, one can also see the latest state of the panel and open the whiteboard client with one click.

Several panel-specific functions are available on the *actions tab* of a panel (see Figure 2). The most important one is writing sticky notes and sending them to the panel. Another important function is adding pictures. Users can either upload an image from their computer or paste an image URL in the sticky note text input field. In the second case, the image from the web will appear in the whiteboard client. It is also possible to copy a panel and then continue in a separate "branch" with the same content. Additionally, users can export a graphical representation of the whole whiteboard surface or the texts of all sticky notes as a CSV file and share the panel with non Tele-Board users by sending a link to the panel.

The fourth tab view is the *history tab*, which is especially important for asynchronous work. Starting from the most current state of a panel, users can go back to any state of the whiteboard content (see also the Server Component section below) and continue working there or download or share this state.

Whiteboard Client

The Tele-Board whiteboard client is the digital equivalent of a traditional whiteboard. It is a Java application and can therefore be opened on most computers. Users just need to go to a panel page in the web portal and start the whiteboard client. The respective panel content will be loaded automatically.
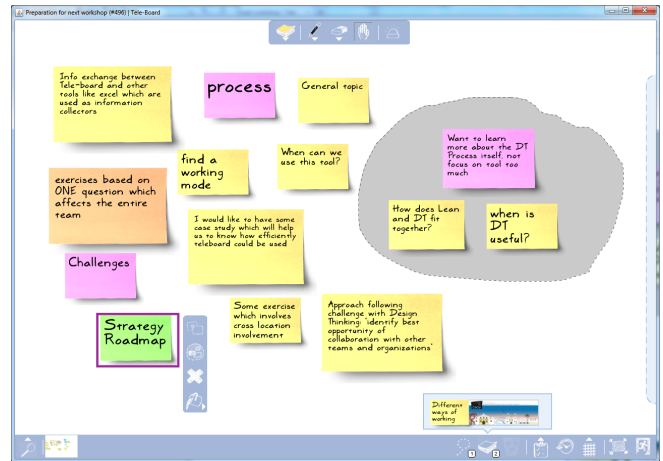

Figure 3. The Tele-Board whiteboard client. It offers standard whiteboard application functionality such as writing with a pen, erasing and panning the surface. It is possible for users to create sticky notes and perform several operations with selected sticky notes, for example copy, cluster, delete, recolor. Sticky notes and images from the Web portal or mobile clients arrive at the bottom of the whiteboard client and can be dragged to the working area.

The top menu offers basic functions such as creating new sticky notes, the pen mode for writing, the erase mode for deleting pen strokes and the move mode for panning the whiteboard surface. Sticky notes can be selected directly. A context menu offers more advanced functions such as, copy, cluster, delete, and recolor (see Figure 3). A cluster of whiteboard elements can also be created by encircling them. This means, it is possible to move around several sticky notes and pen strokes.

Sticky notes and images sent from the web portal, or a mobile device, arrive in a dedicated area at the bottom of the whiteboard client. From there, the user can drag them onto the whiteboard surface.

Digital Sticky Note Pad

As a digital equivalent for paper sticky notes, we offer different applications for writing sticky notes on mobile devices. Though we regard this way of creating sticky notes as an important part of the Tele-Board system, it could not be used by the team because the required devices were not available to them.

Server Component

The Server Component connects all parts of the Tele-Board system (see Figure 1). All events are transferred as Extensible Messaging and Presence Protocol (XMPP) messages and this keeps whiteboard clients synchronized. That is to say, all users who open the whiteboard client of the same panel, always see the same content and can work on the same items.

In order to keep the server's database consistent, we implemented a "last writer wins" strategy [18]. However, there is also the option of stopping the synchronization of whiteboard panning and zooming. Users can work at different areas of the virtual whiteboard without disturbing each other. All pen strokes and sticky notes are still synchronized.

Besides synchronizing all clients, the server component also stores all events in a database, which is the basis for the history tab in the Web portal. For more information, see [8]. When users send new sticky notes with mobile devices or via the Web portal, they are stored in a queue until they are dragged onto the whiteboard. That is to say, users can create sticky notes without opening the whiteboard client and add them later or even let other users add the notes to the board.

ORGANIZATIONAL AND DEPLOYMENT CONTEXT

As described above, Tele-Board was mainly developed for creative ways of working, such as design thinking. In 2011, an initiative for introducing design thinking was started in a large global IT company. In general, the goal was to use a *"human-centered approach to problem solving that helps people and organizations become more innovative and more creative,"* [2] as it was introduced by the design firm IDEO and applied at companies like Procter & Gamble [21]. After seeing a demonstration of Tele-Board, a team manager at this company decided to use it for his newly created team working between Germany, Italy, and India.

For his team, the manager had two incentives to apply design thinking and to use Tele-Board. Following the corporate strategy, he wanted his team to work in a more user- and customer-centered manner and be more creative in general. Additionally, he was looking for a way that his distributed team could work together more closely and make use of their diverse cultural backgrounds in addressing different markets. The first difficulty was that team members were in three different locations and two time zones. Additionally, the team was set up recently and consisted of people who did not know each other earlier. The members also brought different levels of expertise with them regarding their new tasks.

As part of an IT company, the team's job was to create pre-configured parts of a larger software that are ready to use at once by the customer. Though some software adjustments had to take place, most members of the team never did any coding. While some were involved in coding, others worked exclusively on general configuration, documentation, or translation. In their meetings, it was very important to make arrangements with each other and coordinate tasks. All team members worked on several pre-configured software parts at any given time. This work also involved people from outside of the team, some of whom were located in other countries, e.g. China, or the United States. There was a biweekly global team meeting where organizational topics and new ideas were discussed with the manager. Before our study, the team used video conferencing as the means of communication and oftentimes also a desktop sharing application.

Although the manager saw a demonstration of Tele-Board with digital whiteboard hardware and acknowledged the ad-

vantages of it, he told us that he could not provide this hardware at each location and that it was also not realistic to reserve the same meeting room (with this hardware) all of the time. Therefore, he wanted his team to start using Tele-Board with their standard laptops.

For the study, we worked with a team of 25 people (13 female), with 15 of them located at the company's headquarters in Germany (DE), 2 in Italy (IT) and 8 in India (IN). While no team member was a native English speaker, it was the language used in meetings. The team members came from different academic backgrounds. This resulted in teamwork that was quite interdisciplinary. During the course of our study, 5 people from another department joined the team. On average, the length of service with the company was higher for the German team members (on average 13.5 years) than those from India (avg. 6.3 years) and Italy (avg. 8.5 years). Differences in expertise and addition of new members to the team necessitated knowledge transfer across locations.

Two months before the beginning of the study, we conducted interviews with 6 people out of the team (2 female, 4 male; 4 Germans, 2 Indians) for about 30 minutes each. We wanted to find out more about their current challenges with regard to global teamwork and what they expected from a more creative way of working and a new tool.

Challenges for the Team

Working in a newly created team, with three different work locations and various levels of expertise, was viewed as a challenge by the members. Thus, with new working methods and a new tool they expected to improve international collaboration and teamwork in general. They wished to work in a more user-centered way, and with the introduction of design thinking they hoped to get in touch with more stakeholders who were involved in creating pre-configured software packages. As these packages are sold worldwide, they saw their diverse set of knowledge and contacts in different countries as an opportunity for building better solutions. However, from collaboration on past and present projects they knew that distributed collaboration was not always easy. Although two interviewees said that they could clarify some issues over the phone or via instant messaging, others saw calling their remote colleagues as a hurdle:

"Perhaps it's the distance and the time difference, but you don't just pick up the phone and say: I have to tell you an idea I just had. That just doesn't work. I mean, you don't want to steal someone's time with any vague idea." (DE7)

With co-located colleagues one could just walk by the office and see if the colleague had time. But this was not always possible, for example if the colleague kept different working hours. As also reported by other researchers [6, 32], time zone differences were a *"major pain point" (DE3)* in collaborative work. However, the team we studied saw it as an advantage that they needed to deal with only two time zones with a time difference of less than five hours. In fact, they hoped to leverage the longer time span of working hours.

Another difficulty for the communication with other locations was language barriers. As already stated above, no one spoke

English as the first language and therefore spoke with an accent. This could be hard for others to understand and consequently lead to misunderstandings. The same was true for formulating ideas and thoughts in English:

"When you have an idea or want to say something spontaneously in another language, you first have to think: now, how do I phrase this? And this is not only our problem that we have to speak English, it's the same for people in India and Italy. Nobody can speak their first language and I think this is indeed a little handicap." (DE7)

Especially the topic of idea generation and collecting the points of view from people with diverse backgrounds and countries is seen as a great advantage of global teamwork. However, the interviewees said that this is difficult over distances with their current tools. Of course, standard office applications can be used, but the coordination is difficult and they cannot share ideas outside of these applications:

"We had a meeting two weeks ago with a colleague at another location in Germany. While one was drawing something on a whiteboard, the person who was not in the room was lost, because he could not follow the sense of the discussion." (DE3)

As underscored in this example, informal collaboration is generally poorly supported in current systems [11]. However, it was quite important for the team, because they needed to *"get the new colleague on board" (DE4)* and this often happened via informal exchanges within or between offices next to each other:

"The state of knowledge is still very different. I'm quite new in the team and the colleagues in India and Italy as well. But I am lucky that I'm here in Germany and there are many people who have been here for a longer time and really know a lot. No matter if it's about organizational stuff or domain knowledge, I have it directly at my office and that's really convenient." (DE7)

How much and in which way Tele-Board could fulfill the stated expectations of the team and their manager and support distributed collaboration in their office setting was examined via server logs and interviews after three months of use.

EVALUATION
Tele-Board was introduced to the team in a workshop at the beginning of February 2012 where all of the functions were shown in detail and the participants could practice using them. Afterwards, the team started to use Tele-Board during their daily work.

In this section, we will first report on some usage statistics from the system's log files. Afterwards, we outline the findings from interviews with most of Tele-Board's users.

Usage Statistics
To create the following diagrams we analyzed the log file data from February 13 until May 11, i.e. twelve weeks. Twenty-five members of the team (15 from Germany, 8 from India, 2 from Italy; 13 female, 12 male) had user accounts, though 5 of them (DE9, DE10, DE11, DE15, IN8) joined the team only after about 6 weeks.

In the first three weeks, only three to four people used the systems, but in the following weeks more and more users were involved and whiteboard events increased. During Easter vacation time in Europe the number of users dropped, but afterwards we saw a continuous increase of users and whiteboard events again.

Working across time zones
Time zone differences can be a challenge for teams at different locations. But as Tele-Board also supports asynchronous ways of working, we were interested in the distribution of working hours. Figure 4 shows the aggregated number of users for every hour of the day for the entire 12-week period. For example, we can see that all users in India had worked with the system between 12:30 pm and 4:30 pm local time at some point during the study period. Between 8:30 am and 9:30 am at least half of the users connected to the system one or more times.
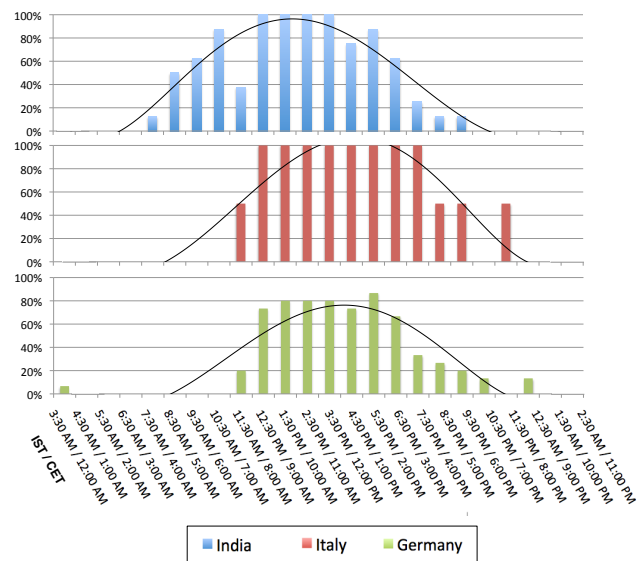

Figure 4. Distribution of user involvement throughout the hours of the day and over the whole study period. Locations are distinguished by colors; the two involved time zones are Central European Time (CET) and Indian Standard Time (IST).

The team mostly followed the pattern of typical working hours from about 9am to 5pm local time. Apparently, the overlapping synchronous work time was used more intensively than the time spent working alone. This often meant that the Indian team members were working until 6:30 pm or longer. In further research, we want to investigate if this intense synchronous use can also be observed in teams that have fewer overlapping working hours. We expect to see more asynchronous work because it is likely that people prefer working during the standard office hours at their time zone, as we can partly see with the Indian team members.

Different usage patterns
Figure 5 shows a selection of panels and how they were used from week 4 until the end of the study period. The size of the circles indicates how many users were involved each day and the colors show the location of the respective users.
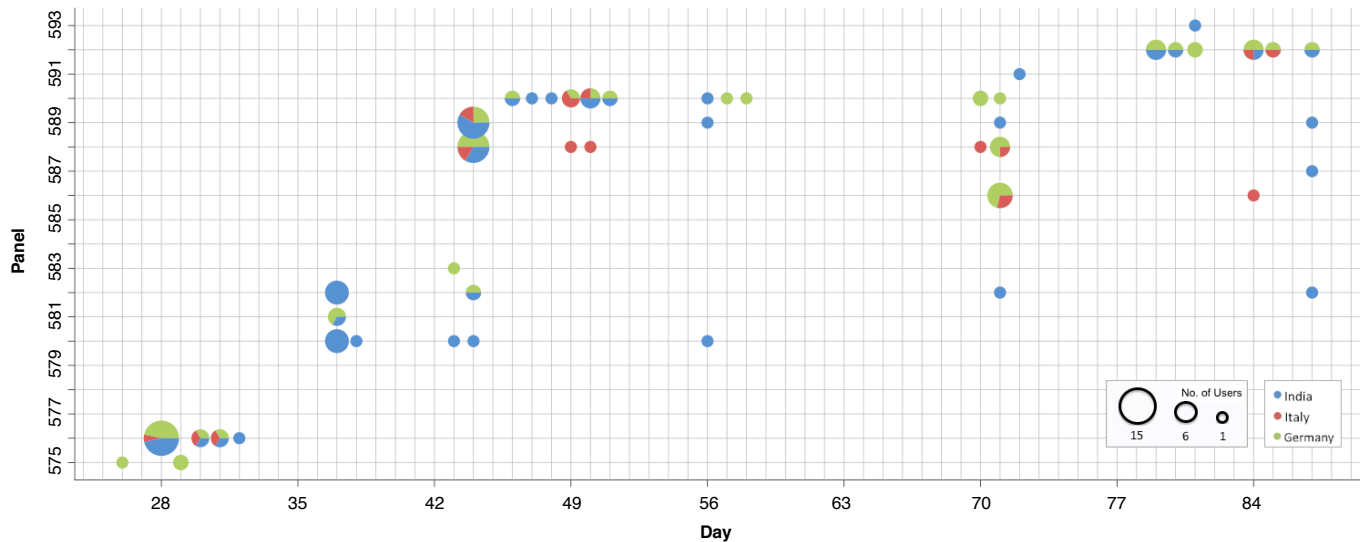
Figure 5. A selection of panels and their user involvement structure over time. The size of each circle displays the number of users active on a certain day on a certain panel. The colors indicate how many people from different locations collaborated with each other. Some panels were only used in a few synchronous global team meetings while other panels were used by only a few participants asynchronously.

The interactions on the panels reveal different usage patterns. It seems, for example, that panel 590 was used for a long-term feedback collection activity. In contrast, Panel 589 appears to be used primarily as an idea sketchpad during a meeting on that one day. After this point, however, it only served to document meeting recap (see "Results from Interviews section for more details). Looking at the different panels, we can see that there is no single way of working with Tele-Board; rather people shifted between working alone, in small groups, and in larger groups. They used the panels during different time periods and manipulated the content asynchronously as well as synchronously.

Giving users the possibility for easy transition between working together and alone in order to facilitate "loose and tight coupling" is important for distributed groupware [10]. Our users also appreciated that Tele-Board not only provided one way of working but several (see subsection "Support for Different Ways of Working").

As an indicator of collaboration among Tele-Board users, we examined how many people worked with the same content, i.e., the same sticky notes. It turned out that almost half of all sticky notes created during the study period were moved/modified by at least 2 people over the course of the study, with the highest number of users editing as many as 8 sticky notes (average: 2.08, SD: 1.44).

Activity per location
The most interesting fact we could derive from the log data was that the activity of all Tele-Board users was not evenly distributed across the different locations (see Figure 6). For all interactions with the system – number of sticky notes created, number of whiteboard events, number of whiteboard client sessions, and session duration – were higher for users at the company's subsidiaries in India and Italy. Although there were some very active users at the headquarters in Germany,
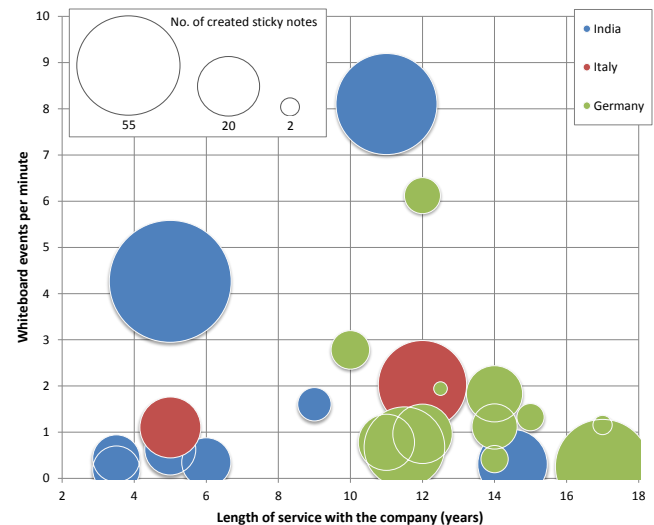

Figure 7. The level of activity of all Tele-Board users in relation to their length of service with the company. Each user is represented as one circle. The number of sticky notes created is expressed by the size of the circles. Based on their location on the y-axis, the circles also show whiteboard activity in terms of whiteboard events / session duration.

others contributed little or nothing. However, four of the five new users who joined the team after half of the study period are located in Germany. This difference in contribution is also reflected in the median and standard deviation values of the different activities (see Table 1).

Because the length of service with the company in Germany is higher on average, we examined whether there is a relationship between the length of service and Tele-Board activity (see Figure 7). In this figure, the size of the circles shows the number of sticky notes a user created (each circle represents a user). The y-axis indicates the ratio between whiteboard
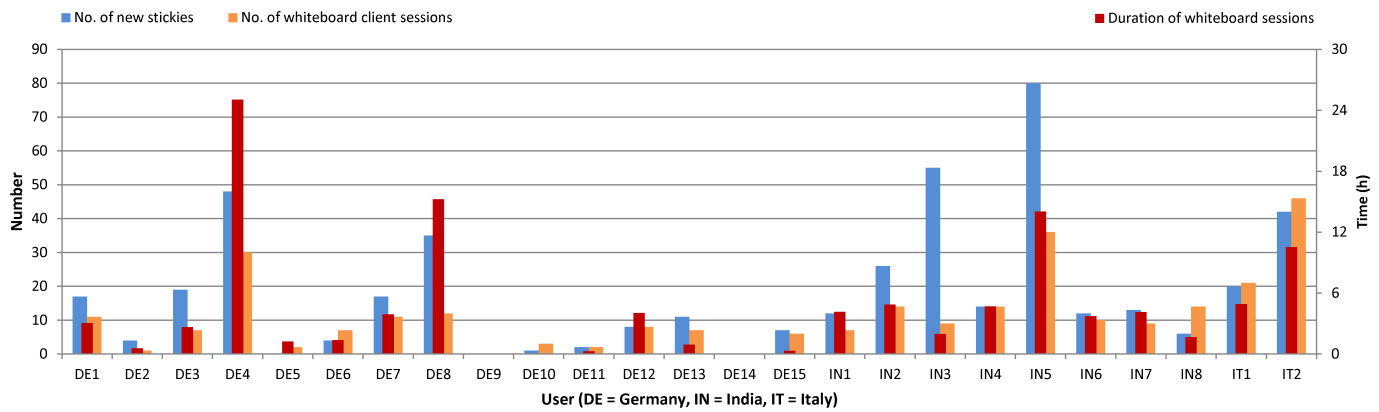
Figure 6. Activity of all Tele-Board users. The left y-axis indicates the number of whiteboard client sessions (orange) and the number of created sticky notes (blue) per user. The right y-axis and the red bars show how many hours each participant used Tele-Board within the three months of our study.

events (i.e., every interaction with the whiteboard client) and session duration (i.e., whiteboard events per minute). This shows how active users were after starting the whiteboard client. Please note that three German users do not appear in this figure because they did not write any sticky notes. Though the statistical values in the table show that the German users generated fewer whiteboard events, started the whiteboard client less often, and wrote fewer sticky notes, a lot of them used the whiteboard actively once they initiated a session. This is indicated by the ratio of whiteboard events per minute. However, we could not observe a relationship between activity and length of service with the company.

Location		No. of sticky notes	No. of whiteboard events	No. of whiteboard sessions	Session duration (hours)
DE	AVG	11.5	181.7	7.1	3.9
	MED	7.0	108.0	7.0	1.2
	SD	14.0	230.9	7.5	0.3
IN	AVG	27.3	651.4	14.1	4.9
	MED	13.5	129.0	12.0	4.1
	SD	26.3	1225.4	9.3	1.2
IT	AVG	31.0	803.5	33.5	7.7
	MED	31.0	803.5	33.5	7.7
	SD	15.6	675.3	17.7	0.2

Table 1. Average, median, and standard deviation values for all activities with the Tele-Board system per location for the study period of twelve weeks.

We believe that the main reason for the variation in Tele-Board use across locations is based on the difference in potential benefits, as described by Gutwin et al.'s study on informal collaboration [11]. As mentioned by user DE7 in the *Challenges for the Team* section, there are many domain experts at the headquarters and the German users can meet them informally on the floor or go to their office with a question. Therefore, the benefit of using Tele-Board is not as high at the headquarters as it is at the subsidiaries and maybe not *"worth the effort of initiating and joining into a collaborative session"*[11]. Especially with regard to knowledge exchange, users at the subsidiaries see Tele-Board as a place where they can ask questions and discuss them. Instead of spending time writing e-mails, users saved time by utilizing Tele-Board instead. As the analysis of the interviews in the next section

shows, the difference in activity across locations corresponds to the differences in opinions on the usefulness and effectiveness of Tele-Board.

Results from Interviews

We conducted semi-structured interviews with 20 members of the team (10 male and 10 female). 11 interviewees came from Germany, 7 from India, and 2 from Italy. As 4 interviewees (DE9, DE10, DE11, IN8) were new to the team, they did not use Tele-Board yet, but talked about their first impressions and experiences from former collaborative remote work. Each interview lasted approximately 30 minutes. Interview questions focused on the usage of Tele-Board and general communication within the team and with stakeholders outside of the team. The interviews with the German interviewees were conducted face-to-face, while the interviews with team members from India and Italy were conducted over the phone. All interviews were recorded and transcribed. We used open-coding techniques to discover patterns and recurring topics [5]. The main topics we identified in the analysis are described below.

Support for Different Ways of Working

In response to our query regarding use of Tele-Board, the interviewees said that they used it primarily during team meetings in the phases of generating ideas / brainstorming and collecting feedback. All users created sticky notes in the same way: in the web portal by typing the note's content with their keyboard (see Figure 2). All users liked Tele-Board for idea collection in particular, because it worked *"just like a whiteboard, a virtual one, as it is intended." (DE6)* For synchronous work, the team members typically did a silent brainstorming and afterwards discussed and grouped their ideas:

"Normally we have a topic for the meeting, and we agree with the participants to allow some time to post the ideas on the board and then we go back into an all-together mode. Normally these are remote, of course, so we are not sitting in the same room anyway. Then we rearrange the ideas on the board and we start sharing and commenting and working on the ideas that are already posted on the board." (IT2)

Ten out of the sixteen active users told us that they also used Tele-Board for asynchronous work. DE4, for example, first posted his ideas on a whiteboard panel and later presented them in a project team meeting to other stakeholders. In most other cases, a meeting organizer created a panel and sent the link to it with the meeting request and asked all participants to post agenda topics or questions on sticky notes. In the meeting, everyone opened the panel and went through all topics on the notes. Feedback collection could occur the other way around, i.e., someone created a panel during a meeting and all participants were asked to post their feedback after the meeting (see Figure 5). This transition between different ways of working was not available in the other tools that the team was using and was greatly appreciated.

Influence on Efficiency

In the former section, we saw that the team used Tele-Board for idea generation and communicating synchronously and asynchronously. But, as in the case with all new tools a company implements, the real question is how efficiently the tool supported employees in their daily work. Though we uncovered different points of view, half of the interviewees stated that Tele-Board saved them time because more people could work together simultaneously. Because of this, meeting minutes and documentation could be omitted and e-mail correspondence could be decreased.

"Earlier we used to just have an open discussion where anyone who has an idea on a particular topic, presents his or her ideas, and the minutes are taken by one person and finally at the end of the meeting all ideas discussed are sent out as minutes by this person; which is time consuming. It's additional effort for a person to capture the ideas, put them in minutes and send it out. And not all of them speak up during a meeting if they have some ideas. Some of them tell their ideas, some of them don't.

Now that we are extensively using Tele-Board for idea collection, I find that the time for those exercises has drastically been reduced. Because everyone just puts in their ideas and it just takes 2 min. and then it's already in there. Now the person who is hosting the meeting only needs to collect the ideas and put it in a proper grouping. The tool has improved the idea collection phase." (IN2)

Interestingly, we heard such statements from only two people located at the company's headquarters. Additionally, eight out of the nine interviewees who worked at the subsidiaries said that Tele-Board saved time. This shows that the benefit of Tele-Board was considered higher by the Italian and Indian users and corresponds with the usage statistics of more activity at these locations (see Figures 6 and 7).

Most interviewees agreed that there were situations when it was neither efficient nor helpful to use Tele-Board. Such situations included one-on-one phone calls, short meetings where to-dos were discussed (IN1, IN7), as well as document review and project status meetings (IT2, DE2). As the tasks of all team members within their project work were diverse (DE6), some interviewees told us that they rarely had meetings where

they could "think out of the box" (DE2, DE5, DE6) and use of Tele-Board could be beneficial.

Conversely, other users saw no advantage to using Tele-Board when compared with existing tools (DE2, DE5):

"I don't see the added value. Basically it's another tool for making notes. I prefer having a list and all of these sticky notes are just too much information for me if no one groups or categorizes them but just sticks them there. You always need someone who sorts them. I prefer having it structured. I prefer a list that I can work from. Otherwise I have to read everything first, then structure it and that's cumbersome." (DE5)

In general, there were different points of view as to how much Tele-Board could and should help structure a meeting. Some thought it helped structure brainstorming and idea grouping (IN3, IN7, IN8, DE7, IT2), while one user criticized what he saw as the unstructured format of the meeting (DE3) and yet another thought it was good to have more flexibility (DE1).

Some users saw advantages in the asynchronous work as time zone differences could be bridged and it was easier to go on working at a whiteboard panel at any point in time (IT2, DE1, IN1), see Figure 4.

"Sometimes it helps when you are working with colleagues from other locations and you have been doing some tasks and they have to follow up, because of the time difference it's always better you use the tool and you post what you have completed, so you don't wait. Because we have to wait until the German colleagues come in the afternoon. Instead we can just start in the morning, based on what the German colleagues or others have posted. That might help in going faster." (IN1)

Another point where users told us that Tele-Board saved time and effort was with respect to the "clean desktop" policy of the company: all employees are always supposed to wipe off whiteboard content or take away flip-chart sheets and this was not necessary with a virtual whiteboard (DE1, DE11).

Influence on Communication and Collaboration

Though some interviewees perceived that the communication within the team was already very good (DE6, IN2), others saw further improvements due to the use of the new tool. For example, one user found that the tool was advantageous for quieter people. The possibility to communicate was easier when it involved posting a sticky note and explaining it afterwards (DE7). In general, several people agreed that Tele-Board encouraged communication (IN1, IN2, IN7) because people were more comfortable speaking freely (IN5): They lost their inhibitions to say something if they could post it first (DE4, IT1). Especially for asynchronous feedback rounds, participants liked the "anonymous" appearance of sticky notes though it was possible to track the author of the sticky note. Interestingly, the feeling of anonymity praised by some was viewed by one participant as potentially inhibiting users from posting (DE2).

Having everybody's input in *written* format was important to many users (DE11, DE3, DE5, IN6, IN7, IT2) in order not to forget something and to improve understanding of what

people wanted to say. As stated at the beginning, problems with audio connections and accents of non-native speakers sometimes hampered communication (IT2, DE5, IN7). This is consistent with the findings of Yankelovich et al. [34]. In such cases, written sticky notes can assist in communication:

"When we talk over the phone, it might be that their voice is not clear and we could not understand them properly. In that case Tele-Board was very helpful because we have written format and we get to see what they really want to tell us." (IN7)

Overall, the manager of the team also saw an improvement in mutual understanding:

"The understanding is definitely better than before. I mean, I see their results. And when I talk to them separately at regularly scheduled meetings I can tell that they are talking less about different things. The big picture is more consistent. It's better, but not perfect." (DE8)

Interplay with other tools
Tele-Board offered a new way of working and the whiteboard and sticky note metaphor was different from other digital tools used in the company. It was our goal to introduce a virtual whiteboard for remote collaboration which was, as one user described it, *"a perfect addition to the other tools"* (DE6).

As the team formerly used MS Excel for collecting ideas and feedback, some interviewees compared Tele-Board to this tool. One user expressed the feeling that she used it like she used Excel, just with easier clustering (DE7). The team saw the main difference and advantage as the ability to enter data simultaneously or in *"real-time"* (IN1, IN2, IT2). Others thought it was easier to use than other tools because everyone knew the analog equivalent and it was more fun to use because of its colors and playful character (DE4, DE1).

"[..] it's very receptive, because it's colorful, it's sorted, you can concentrate on the visuals and that's easier to remember than words on an Excel sheet. We did it with Excel before and the rows and columns don't stick in your head. But if you remember the colorful stickies you can say: yes, the pink topic was below the orange one, it stays into your head as a picture." (DE1)

Regardless of whether people liked working with whiteboards and sticky notes, we often heard that they always had to transfer the content into a MS Office document. As the manager put it: *"It's good for collecting ideas as a first step towards a solution. But it has to go on..."* (DE8). Tele-Board could be *"a mind map where it is easy to add links and documents"* (DE8) or as some participants stated: *"a Powerpoint slide-deck"* (IN2, DE5, DE6).

An additional question to participants was how much they used video conferencing for their remote work. Most of them said that they usually did not use it for their project work, because it was difficult to get a video conferencing room at each location. For this reason, especially in the case of small meetings, video conferencing was seen as not worth the effort.

But they also said, it was not very important to see the faces if they saw the same content on the screen (IN2, IN6, IN8, DE4, DE5, DE6, IT1, IT2). One user thought it could even have a negative effect during brainstorming because one is distracted by the faces (DE3), which is consistent with other research [3].

Tool Introduction
Introducing new tools in a corporate environment is challenging because employees do not have much time and are compelled to learn several new tools, especially at the beginning (DE2, DE9).

In our case, the manager of the team promoted the use of Tele-Board from the beginning (DE8). Some team members accepted it passively (IN8, DE3, DE6) while others viewed it negatively *"I think a lot of people use Tele-Board because our manager wants it"* (DE2) or positively *"It is good that our manager forces us to use it, someone has to convince the others"* (DE9).

Several users saw it as an advantage that the use of Tele-Board was not difficult to learn (DE6, IT1, IN8) and that new users could start working right away after the main features were explained to them. These features were: creating sticky notes and adding them to a board, changing the color of sticky notes, creating clusters, creating a panel, and starting a project. We heard from the new team members that it was not too difficult to learn how to use Tele-Board (DE11, IN8).

Members of the team thought that they could get feedback from other stakeholders (e.g. product owners or consultants) more easily and on a regular basis if these stakeholders also had a Tele-Board account (IN1). As the tool was only introduced to team members, no automatic routine for creating other users was set up. However, Tele-Board could certainly help in collaborating with people outside of the company as well. As the manager put it:

"In a world with less budget and possibilities to travel to a customer, a platform for quick exchange is very valuable. It may help to faster get an understanding for the customer's needs." (DE8)

DISCUSSION
From usage statistics as well as interviews, we can tell that Tele-Board became part of the team's repertoire of work tools during our study. Though the time they used it (in terms of session duration) may not seem to be high compared to the total working time, we detected whiteboard activity on 46 of the 60 working days (12 weeks of 5 days). Considering that main working time is dedicated to composing and building suitable software packages, we were happy to see that team members included Tele-Board quite frequently in the range of tools for their internal communication and collaboration.

Interviewees stated that they did *not* use Tele-Board for meeting types such as status updates or document review meetings or one-on-one phone calls. For these kinds of meetings, existing tools in a corporate environment do the job and Tele-

Board does not aim to be their substitute. With Tele-Board we provided the team with a tool that complements existing tools with new functions (DE6). Now, they had the possibility to generate ideas and input at the same time, and they could also continue working on the same content at a later point in time, whenever convenient.

Several users thought that Tele-Board saved time because it allowed them to work together in real-time without anyone having to wait for others to finish. Work was shared, which also meant that no one was burdened by having to write documentation or minutes of the meeting.

We could also see that Tele-Board improved team collaboration. The manager confirmed that mutual understanding (e.g., of the project contents) increased when using Tele-Board. A second improvement was the feeling of shared experience and sense of co-presence that working on the same whiteboard gave team members [3]. The *written* format of sticky notes, in contrast to audio-only meetings, was another advantage for communication among team members because it mixed verbal and visual communication. Moreover, working with the same artifacts simplified the verbal communication and made interaction more efficient [10]. Our interviewees confirmed this and stated that it was easier to understand others and express one's own opinion. Additionally, quieter participants were more likely to be heard.

Of course, other tools also provide the possibility to share in written format, but they either do not support real-time participation (e.g. MS Office products) or show input in a linear format (e.g. instant messengers). With the help of sticky notes, Tele-Board allows the possibility of rearranging and sorting one's own input as well as the input of others. The team used this option for creating schedules and plans for meetings or for collecting questions they had for other stakeholders. Oftentimes, similar ideas appeared, but then they could be grouped together and a shared interest in this topic became visible. Additionally, sticky notes encourage going from structured meetings and data sharing to the *"far messier tasks of generating ideas and building consensus around them"*[2], which is desirable when a company wants to apply design thinking or similar methods.

Tele-Board combines advantages of synchronous collaboration with the possibility of asynchronous input. Users could easily start working before a meeting or go on working after a joint session with their colleagues. From usage statistics and interview statements we saw that the team actually followed such work practices (see Figure 5): some panels were mainly used for one joint meeting; others were used repeatedly over time. Additionally, entering ideas whenever they occurred made the team less dependent on different time zones and office hours (see Figure 4).

By complementing existing tools, Tele-Board offered a new communication channel that was used by team members, especially at the subsidiaries. Feedback from interviews and usage numbers from log files showed that users from Italy and India interacted more with Tele-Board than users from the headquarters in Germany (see Figure 1). As domain and task experts were located mostly at the headquarters, German users did not have the same motivation to use a digital tool for knowledge exchange as the Italian and Indian users did. German users could simply take a question directly to a colleague. By contrast, an Indian user told us that he and his colleague used Tele-Board to collect questions on a panel and then discussed them with more experienced colleagues in Germany.

From this study, we learned that a prerequisite for using a tool like Tele-Board is easy availability to all team members. The manager told us that a whiteboard software tool that is available only on dedicated whiteboard hardware and in special meeting rooms will not be used very often. If, in the future, the hardware becomes available on a general basis, the Tele-Board software could support work practices that are more similar to working at traditional whiteboards. Nevertheless, it is essential that Tele-Board remains available to users on standard computers as well. Moreover, we should make Tele-Board accessible to those outside the team and also to consultants or customers outside the company, in order to improve collaboration and foster user-centered work practices.

Limitations
Our study was conducted with a single team in one company and was influenced by the structure and composition of this team. From the 25 users there were only 20 active users because 5 people joined the team only after half of the study period. Future work in other organizations and teams is needed to verify if the results are similar or if advantages and disadvantages of Tele-Board differ across teams and contexts. More users from various locations and in different areas of work are necessary in order to draw generalizable conclusions.

CONCLUSION
In this paper, we presented the Tele-Board system, which offers the possibility of fostering creativity in globally distributed teams in corporate environments. We conducted a three month usage study with a team in a large IT company based in three locations on two continents that used Tele-Board for its work. We collected quantitative data from usage logs as well as qualitative data from interviews with the users.

We learned that the "optimal" system setup we created in our lab could not simply be deployed in a company as is. It needed to be adjusted to a user's daily environment and equipment, which meant standard computers instead of digital whiteboards and sticky note hardware.

However, users could still benefit from the system because it enabled them to engage in real-time idea generation and feedback sessions over distances. It also provided them with a platform for knowledge exchange anytime they wanted to use it. Tele-Board supports a smooth transition between synchronous and asynchronous work: a user can either work along at a panel asynchronously or several users can connect to the same panel to work synchronously. Everyone could choose his or her preferred way of working, depending on the respective (team) situation. System log data and interview results showed that both ways of working were used by the

team. It was therefore important that they were able to shift easily between working alone and working together [10].

Moreover, in the interviews we found that a shared workspace and its artifacts simplified verbal communication and understanding due to the written format of sticky notes. The graphical note appearance of sticky notes made them ideal for arranging and sorting.

Interviews as well as log data showed that Tele-Board users at company subsidiaries used this extra communication tool considerably more than those at the company's headquarters. Tele-Board provided a potentially promising channel of communication to improve joint work across company branches. This is an area we will examine further in our ongoing research.

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