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Transferring traditional design work to the digital world – does it work?

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Although computers and other digital tools are well accepted in many design companies these days, for some activities, traditional tools are still preferred. Especially when new ideas should be developed and the design problem is not yet well defined, people tend to rely on pen, paper and whiteboards. Nevertheless, for these working modes digital tools can be beneficial as well. Ideas and results can be saved for future use, parallel lines of thought can be pursued, and in particular creative work for geographically distributed design teams can be enabled.

In this paper, we present the findings from a qualitative study, in which design thinking teams used a digital environment for their creative work. The given challenge was intentionally not well-defined and involved various design thinking phases, such as user research, synthesis, ideation, and prototyping. As all participants were used to traditional tools, we focused on the comparison between an analog setup and digital whiteboards and sticky notes. Results show that all participants could well accomplish their usual way of working with the digital environment and came to satisfying results. However, the acceptance and readiness to use a digital system varied among participants. We will explain which factors are most important for the adoption of a digital system, for which methods and activities it works best, and how well customary hardware is suitable for the teams' working modes.

Keywords: design thinking, digital whiteboard, analog vs. digital

Introduction

In the early phases of design work and creative tasks people tend to use traditional whiteboards as well as paper and pens for easy and quick ways of working. There is no need to explain and learn working with these tools and team members from all disciplines can jointly work together (Brown, 2008). Additionally, it is easy to sketch ideas, which improves communication and externalization of ideas (Fallman, 2003; Klemmer, Hartmann, & Takayama, 2006).

However, in nowadays workgroups there is a strong need to digitize working materials and results. The final design needs to be presented to managers and increasingly more often a documentation of the design evolution has to be communicated in forms of documents or slide decks as well. In addition, when using digital working materials, teams can easily work independently from their location. All information can be transferred to any location and if a team member cannot participate, everything can be saved and it is possible to continue working later.

In order to overcome the gap between traditional ways of working and the need for digitalization, we asked ourselves: what if we could preserve the analog feeling and still have the digital advantages?

In this paper, we will present the results of a qualitative study with design thinking teams working in a digital environment. We will give a thorough report on our observations, findings from a questionnaire, and participant's as well as expert's evaluation. We discuss in which ways and settings it makes sense to "translate" the physical world to the digital one and when users are willing to accept working in a digital environment.

Tele-Board – a digital whiteboard software suite

As presented in former publications (Gumienny, Gericke, Quasthoff, Willems, & Meinel, 2011), we created a software system that serves as a digital equivalent for traditional whiteboards and sticky notes. We aimed at preserving the metaphors of the traditional tools as much as possible and added some advantages from the digital world. Thus – with the help of digital whiteboard hardware – it is possible to write at a whiteboard, rearrange sticky notes, change the color of sticky notes, or group them in clusters that can be moved as well. All actions are automatically stored and can be re-edited at any location. For the creation of sticky notes, participants can use the whiteboard, an iPad, a TabletPC, a digital pen or a keyboard. That is to say, our tool supports every kind of interaction that

is possible in a traditional setup, with additional functions concerning archiving and editing of the content.

Tele-Board Components

The functionality of the Tele-Board software system is divided among different components, which are as follows: a *Web application,* a *Whiteboard Client*, a *Sticky Note Pad*, and a *Server Component*.

Web Application

The *Web application*[1] serves as the entry point to the Tele-Board system: users can browse and manage projects and associated panels. Here they can also start the whiteboard client and work on the panel's content. Users only need to click on a whiteboard preview picture and the client software is started from the browser. It is not necessary to install the software, which makes it easily accessible from any computer.

Whiteboard Client

The Tele-Board *Whiteboard Client* is a Java application as we were looking for a platform independent solution. Its main functions comply with standard whiteboard interaction: writing on the whiteboard surface with pens of different colors, erasing, writing sticky notes. Additional functions as panning the whiteboard surface, cut & paste, clustering, re-coloring sticky notes, and deleting elements enhance the working experience (see Figure 1).

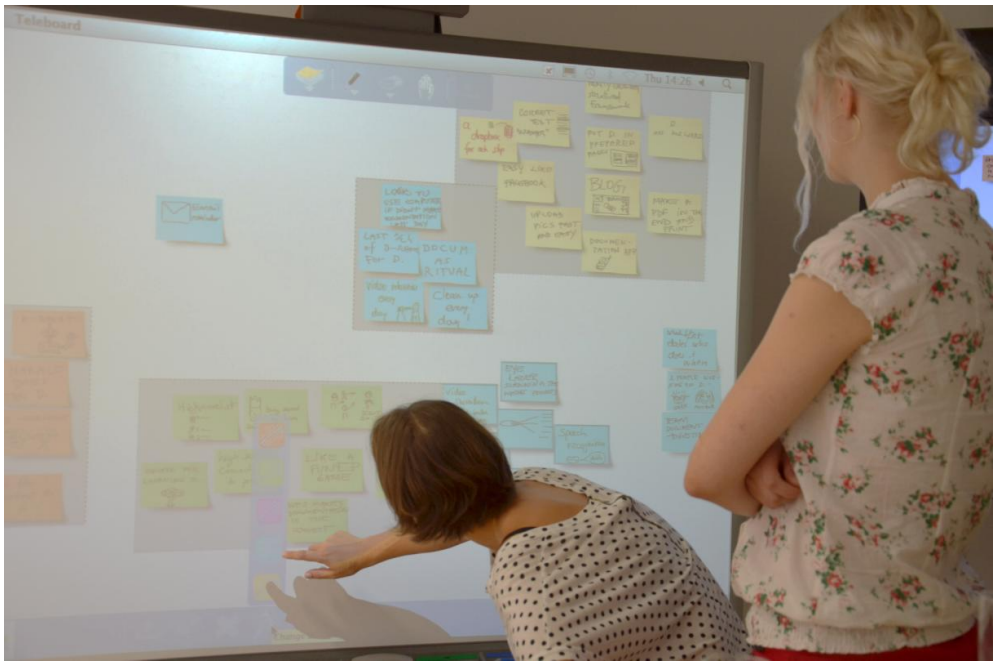

Figure 1: Test participants using the re-coloring function of the Tele-Board whiteboard client.

[1] **http://tele-board.de/**

Sticky Note Pad

As an equivalent to paper sticky note pads, we created different applications for writing sticky notes. The Java application is ideal for tablet PCs and other pen input devices. For fast finger input you can use the dedicated Apps for the iPad (see Figure 2), iPhone or Android devices. After creating a sticky note on one of these devices, it can be sent to the whiteboard.

Figure 2: *Sticky Pad HD* App for writing sticky notes and sending them to the Tele-Board whiteboard client.

Server Component

The *Server Component* coordinates all communication between the remote partners. All interactions are transferred as *Extensible Messaging and Presence Protocol (XMPP)* messages to keep the connected whiteboards synchronized. For advanced saving and resuming possibilities, we extended the Server Component with additional functions. That is to say, all whiteboard actions are stored automatically and it is possible to go back and forth in the "history" of the whiteboard content (for more information see Gericke, Gumienny, & Meinel (2010)).

Experiment Setup

In order to find out if it is possible to work with this tool in a similar way as in a traditional setup, we had five teams working on the design challenge "*How might we enable a Design Thinking team to conveniently document their project in a way that fits the needs of all different parties involved?*" The design problem was intentionally fuzzy (Buchanan, 1992) and the teams (with four participants each) were following a design thinking

approach (Brown, 2008; Lockwood, 2009) including different phases and methods, such as storytelling, brainstorming, framing, prototyping, and testing. Each team worked on the challenge for five hours and in the end they were supposed to present a prototype to an expert audience. All participants completed a course at the *School of Design Thinking of the Hasso Plattner Institute in Potsdam*[2] and were familiar with working at traditional whiteboards and other physical tools. Eleven participants were female, nine male and their age ranged between twenty-four and thirty-two years (twenty-eight on average).

In the beginning, we explained all functions of the Tele-Board whiteboard client to the teams and showed them how the digital whiteboard hardware worked. Because we also wanted to know which hardware works best for this way of working, we provided two different types of whiteboard hardware: a *SMART Board 680i2 interactive whiteboard system* (figure 3, left) and a *SMART Interactive Display 6052iB* (figure 3, right). The *SMART Board* projects the content to a special surface that detects interactions through pressure (resistive technology). The *SMART Display* is a LCD display combined with cameras for detecting pen and finger input (DViT technology). Next, we explained how to write sticky notes with different devices: we provided four iPads with the *Sticky Pad HD* App (including special iPad pens), a TabletPC, a digital pen (connected to a laptop) and a laptop for writing sticky notes via the Tele-Board web portal (see Figure 3). The participants had time to try out all functions and to get used to the digital whiteboards and sticky note devices.

Figure 3: Tele-Board one-day challenge experiment setup with two digital whiteboards and a variety of devices for creating sticky notes. Design Thinking team in this picture: Sebastian Mährlein, Johannes Erdmann, Thuy Chinh Duong, Svenja Bickert (from left to right).

[2] **http://www.hpi.uni-potsdam.de/d-school/**

Afterwards, they watched videos of interviews with different stakeholders regarding the design challenge. This part substituted the user research phase, as we wanted to have comparable input for all teams and shorten the overall time for the study. In the following, the teams passed through all phases they knew from their School of Design Thinking education: storytelling, synthesis, ideation, prototyping and testing. In total, they worked at the design thinking challenge for five hours, including a lunch break.

Results

With the help of participant observation, we examined the participant's way of working and the usability of Tele-Board and the hardware equipment. Through post-test interviews and questionnaires, the participants reported how well they could accomplish the given task compared to their usual way of working and how satisfied they were with the digital environment.

Observations

As a main result regarding the time, we found that all teams could accomplish the task and **came to interesting prototypes** during the given time frame. There were no major differences in the timing of the different phases between the teams. We could observe that the ease of use and comfort with the system was **related to general openness and curiosity** towards new technologies and digital tools. That is to say, participants who tried out all Tele-Board functions enthusiastically in the beginning also learned the functions much faster. Not surprisingly, participants who had used an iPad before had less problems using it, compared to others who never had held one in their hands.

With regard to the contrast between Tele-Board and traditional tools, we observed that, in general, the teams' usual **way of working did not have to be changed** and the teamwork was fine. Some participants said that there was **hardly any noticeable difference** between traditional tools and the digital system. They even claimed it to be timesaving compared to the analog ones. On the other hand, some participants had difficulties getting used to the system and said it **would slow down their work.** This was mainly observable with people who were rather cautious with trying out all functions. When they could not find what they were looking for in the first place or the system did something they did not expect, they were afraid to try out other things afterwards. Still, all participants **quickly learned how to use the system** during the course of the testing. We also observed that it was a great advantage when at least two of the four team members walked through the system easily, because they then showed the others what they found out and after a short while the whole team had no

difficulties anymore. In teams where all participants were rather cautious, it took them a longer time to get used to the Tele-Board system. However, this had **no influence on the quality or creativity of the results**. After the experiment, thirteen experts rated the final prototypes regarding their usefulness and degree of unusualness (see von Thienen, Noweski, Meinel, & Rauth (2011), for more information on the expert rating questionnaires). In this evaluation, the teams that needed more time to get used to Tele-Board even had slightly better ratings for usefulness as well as unusualness.

Advantages and disadvantages of hardware equipment

In addition to the interaction design of the system, we also examined different off-the-shelf hardware and its capabilities of supporting a natural, tangible whiteboard and sticky note feeling. Here, we found that all of the existing devices have different advantages and disadvantages. Additionally, it depends on personal preferences which devices our participants would choose. Especially with regard to the **digital whiteboard hardware**, it was not possible to say which of the two boards works best for design thinking activities (see figure 4; on average the display board scored 3.35 points and the projector board 3 points). The **display board** (SMART Interactive Display 6052iB) has the advantage of a high resolution (1920x1080px) and thus displays a lot of content very crisp and without the noise of a projector. On the other hand, the touch interaction is not comfortably usable: it often happened that the display received touch events from the bent fingers when writing with a pen or from the clothes at the wrist of the user. Our users also stated that it felt strange to move around sticky notes on the plain surface of the LCD display, especially when the display gets warmer after a while. The **projector board** (SMART Board 680i2) has a more comfortable surface (like plastic foil) and because the interactivity is realized by pressure, there are no accidental touches. Additionally, because of its size (77’’), it conveys the feeling of a real whiteboard, more than the 52’’ LCD display. On the other hand, it has a relatively low resolution (1280x800px) and it cannot distinguish between hand, pen and eraser input. That is to say, all pens and the eraser tool have to be in its tray in order to switch to move mode. Of course, during intensive project work and with different users, this often let to unwanted pen strokes or confusion of mode switching in general.

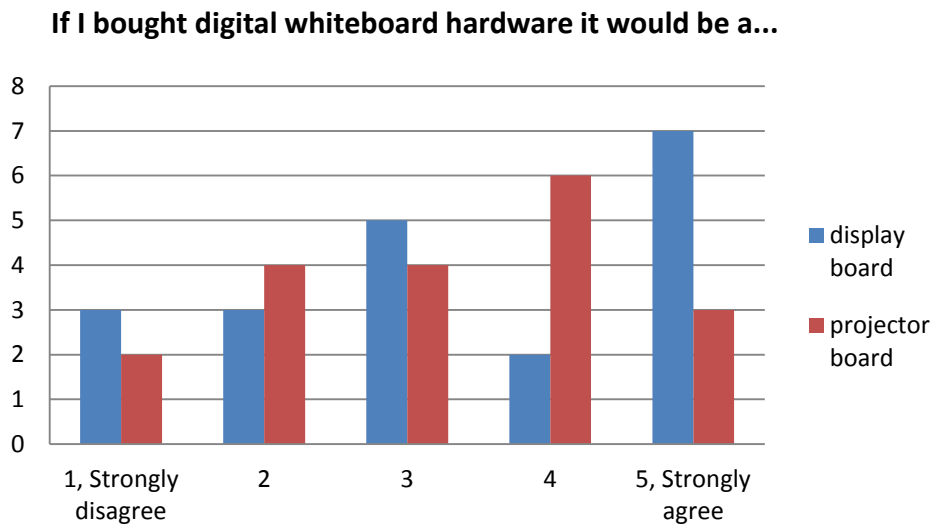

Figure 4: Comparison of digital whiteboard hardware. Participants did not have a clear preference for one of the two boards.

With regard to the different **sticky note devices**, the iPads were very much appreciated because of their mobility and the simplicity of the *Sticky Pad* App. In contrast, the TabletPC was considered being too heavy and therefore not mobile enough. The possibility to write sticky notes with the keyboard via the web portal was appreciated by some participants, as this text is more readable than the handwritten notes. On the other hand, being visual, i.e. drawing something, was important to all teams and thus they preferred the pen-based tools. Some participants explicitly noted that they liked the haptics of paper and thus liked the concept of a digital pen for writing sticky notes. However, the digital pen receiver had to be connected to a computer with a cable and this decreased its mobility and flexibility, which was a problem for the workflow. But, half of the participants did not try out all of the different devices, probably because the iPads worked very well for their purposes (see figure 5).

In general, we saw that it was very important that every team member had their own device for quickly noting down their ideas and thoughts. This way, it was possible to circumvent the missing multi-touch capabilities of the whiteboard hardware to some degree. While one person was operating the whiteboard, the others could still contribute their ideas and discuss the topic as a team.

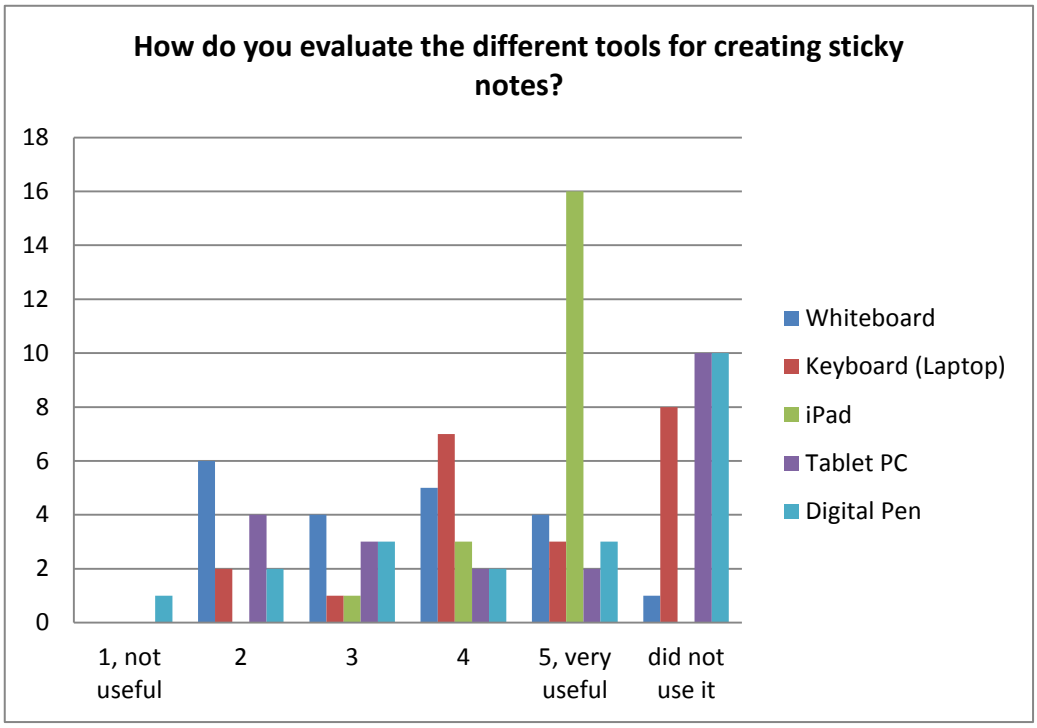

Figure 5: The iPad was the most favored tool for creating sticky notes. The Tablet PC and the Digital Pen were not used by half of the participants although all tools were introduced and tested.

Questionnaires

Right after the experiment we handed a questionnaire to the test participants. They had to answer Likert-Scale questions with regard to the general usage of the system, as well as free text fields with special focus on the comparison between the analog and digital world, and the functions and working modes that Tele-Board supports. In this section, we present the cumulated answers from the questionnaire.

Comparison analog vs. digital

As already indicated in the observation section, the satisfaction and adoption of the digital tools was very differently perceived and evaluated. Additionally, it depends on general personal preferences towards digital tools, which is also reflected in the answers in the questionnaire. In interviews after the experiment, some participants stated that Tele-Board works well for a digital tool, but if they had the choice they would rather work with pen and paper and not be in front of a computer or monitor. On the contrary, others said, that they have to digitize the content anyway at some point and if it was digital from the beginning, this could be omitted (see figure 6, right).

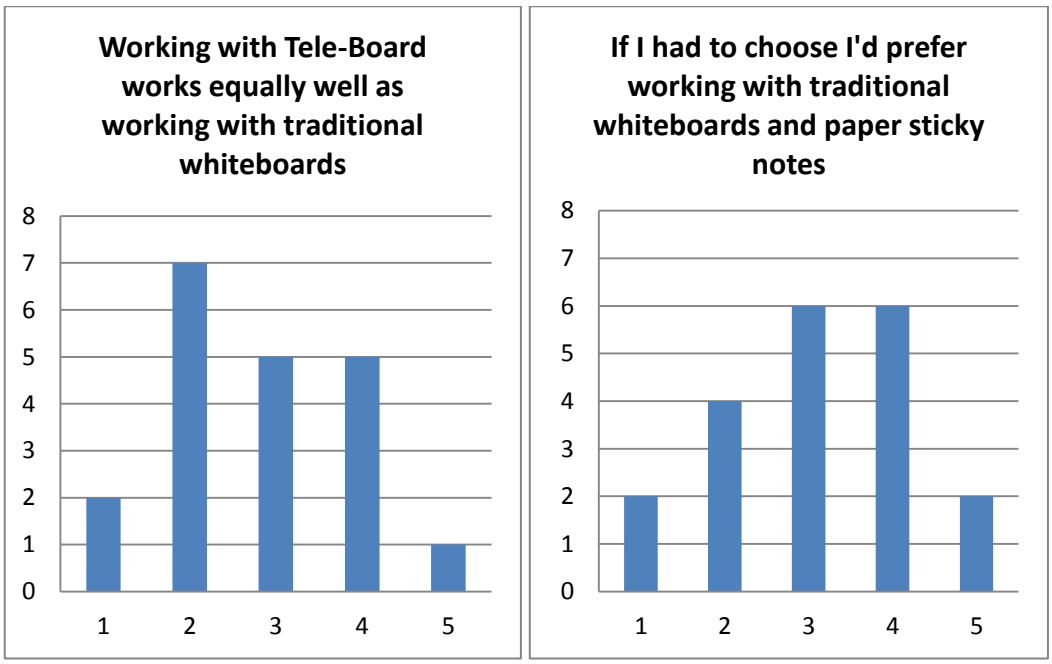

Figure 6: Comparison of Tele-Board with traditional whiteboards and paper sticky notes (1 = strongly disagree, 5 = strongly agree).

No matter how the participants evaluated the digital way of working in general, all of them could point out advantages and disadvantages of the respective boards.

From their point of view, the major **advantages of traditional (analog) whiteboards** are: the possibility to work with several people at the same time, the tangibility or haptic feeling, and the speed, i.e. quick manipulation. Other things that were mentioned are: the ease of use because everyone immediately understands it, the fact that it is cheap and no technical equipment is necessary. Other advantages of normal whiteboard are related to problems with digital whiteboard hardware, as e.g. difficulties with drawing on them and the resolution of the boards.

As the main **advantages of Tele-Board (digital)** the participants mentioned: no waste of paper, automatic saving and documentation, and several special functions, e.g. clustering, changing colors of sticky notes, and zooming. Additionally, they stated the opportunity for remote collaboration and possibility to write sticky notes with mobile devices from any location.

With reference to the advantages of Tele-Board, the participants thought the main **disadvantages of traditional (analog) whiteboards** were a waste of paper and sticky notes that fall down after a while. Furthermore, they mentioned difficulties with documentation and the limited number of available boards: the only way is to take pictures and then clean the boards, with no further possibilities of editing the content. They also mentioned that the boards require a lot of space and have limited mobility.

The greatest **disadvantage of Tele-Board (digital)** was seen as the single touch capabilities of the whiteboard hardware, meaning that only one person at a time can work at the whiteboard. Another problem was the input delay of the digital boards, especially when writing on the whiteboard surface, thereby people described the system as too “slow”. Participants also considered the digital solution being quite expensive and some functions did not work intuitively enough or had bugs. See also the following section on usability and complexity of functions.

Activity support and scope of functions

As the experiment encompassed several hours with different phases of a design thinking project, we were interested if all phases and ways of working were supported equally well or not. Therefore, we asked the participants for which activities Tele-Board worked well and for which activities not.

Tele-Board worked especially well for brainstorming, followed by presenting content, and the synthesis of information, i.e. clustering and sorting ideas. Participants liked the clustering functions of Tele-Board because it was possible to move clusters around and they said they had a better overview than they had on traditional boards (see figure 7). When presenting, they could easily hide and show information with the help of the zoom and panning functions. Additionally, they mentioned that it was helpful to re-color sticky notes. This way, the color could first be related to a person and afterwards to a specific topic. With regard to sustainability, they liked to easily integrate pictures from the internet or a camera and not to print them. In general, they also liked the fact of storing everything automatically and the possibility to go back and forth in the history of the whiteboard content if needed.

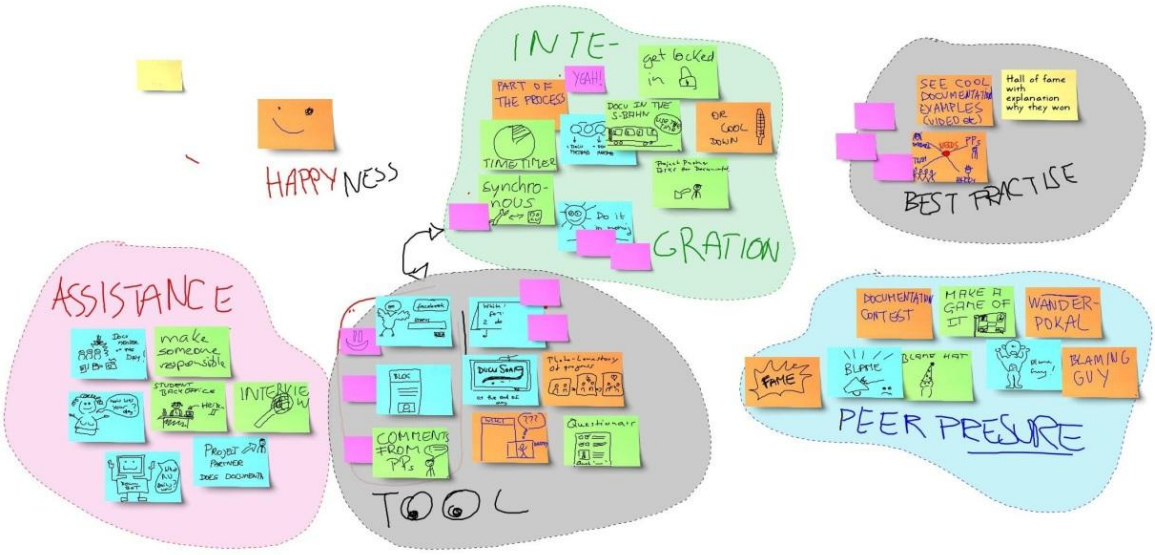

Figure 7: Screenshot of the Tele-Board whiteboard client after ideation. Participants especially appreciated the possibility to create clusters and move them around.

When we asked **for which activities Tele-Board did not work well**, they mainly mentioned: working together at the whiteboard and drawing or writing on the whiteboard surface. Both issues are related to the digital whiteboard hardware; see also the hardware equipment section above. With regard to the software, i.e. Tele-Board's functions, most participants missed an "undo" option. When we started with the design of Tele-Board, we intended to stay with physical metaphors (Mynatt, Igarashi, Edwards, & LaMarca, 1999; Terrenghi, Kirk, Sellen, & Izadi, 2007) as closely as possible. At that time, we only provided all functions that are possible with traditional whiteboards. Gradually we added new functions that provide advantages the analog world cannot offer. Still, we tried to stay with physical metaphors as closely as possible and rarely included desktop-like interactions. Our users were supposed to have the feeling of standing in front of a whiteboard and not a computer. After the experiment, participants told us that they were surprised how "real" the interaction with the digital boards felt, but still, they expected standard functions they were used to from computer usage.

In order to evaluate the usability and general user experience of Tele-Board, we also asked the participants to give their ratings on Likert-Scales. Though there were participants who considered working with Tele-Board being complicated, most people did not. The majority also thought that Tele-Board's functions were easy to understand (see figure 8).

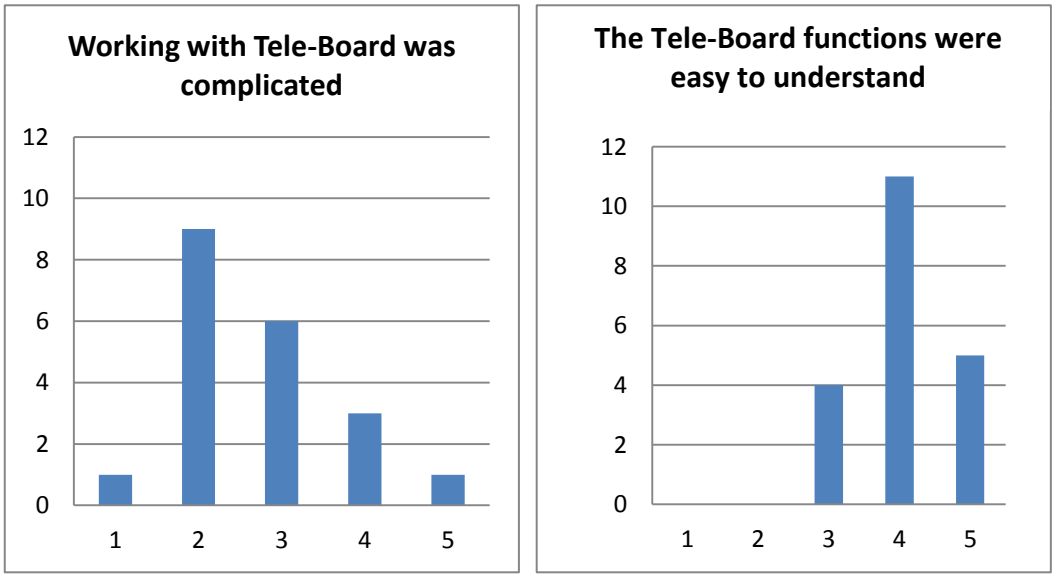

Figure 8: Tele-Board's general user experience compared with the usability of its functions (1 = strongly disagree, 5 = strongly agree).

General Feedback

At the end of the questionnaire, we asked for general feedback, meaning that participants could enter whatever they liked. Thus, the answers were fairly diverse. Some users just thanked for the opportunity to try out the digital equipment, others said which functions need to be improved. The answers also varied with regard to the overall satisfaction. Some were quite positive:

> *"Within the Design Thinking process there was no real difference between using digital or analog boards. Great work :D love it"*

> *"I love the concept of bringing the whole thing to the digital world. The size of the projector whiteboard is perfect. Some detailed interaction paradigms can still be improved to humanize it more."*

Others combined positive aspects with things that have to be improved; especially the digital whiteboard hardware:

> *"I liked the whole experience, nice atmosphere & I liked our idea and working in total with Tele-Board. I haven't expected that learning to work with it is so easy and quick to learn, but the drawing experience is horrible!! Has to be improved."*

> *"If it was a little bit faster and more than one person could work on the same board, then it would be really fun."*

Another participant stated that the digital whiteboard experience was not yet advanced enough for real project work:

> *"It was a great experience working with the Tele-Board, but in my opinion it's not yet advanced for the d-school needs. It was a little too slow and reduced the teamwork since just one person could write on it. I also didn't feel that encouraged being visual because I was too overwhelmed by the technology and a little afraid making a mistake."*

In the Likert-Scale section of the questionnaire we also asked participants to rate the general usefulness and if it was ready to use for real projects. Though participants can well imagine using Tele-Board for other Design Thinking activities, the majority is unsure if it is ready to use yet (see figure 9).

As already stated before, the hardware equipment plays a decisive role for the general experience of digital design work (see former section).

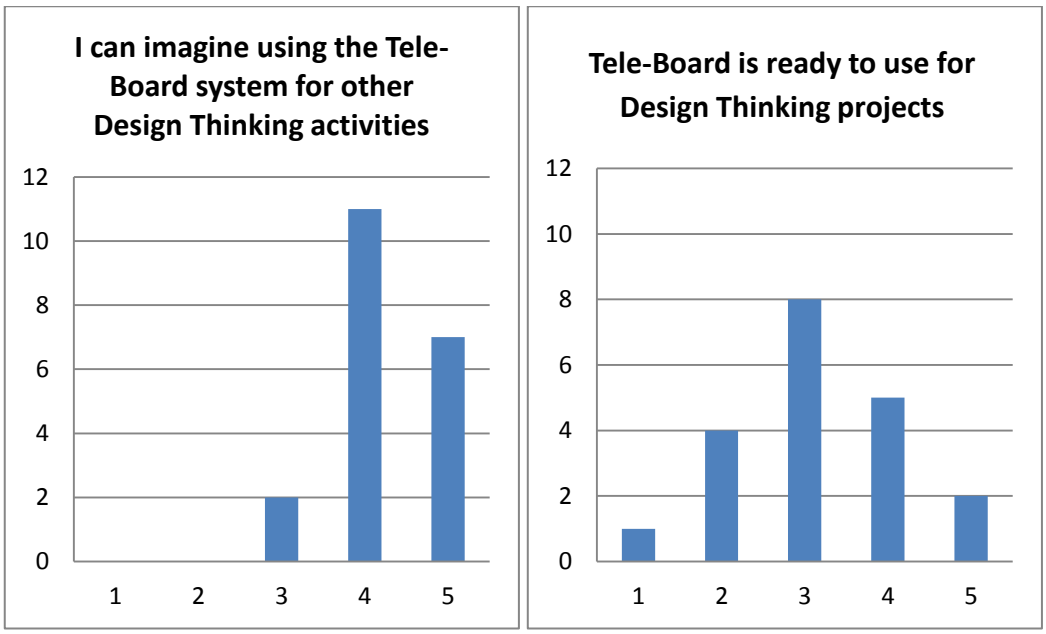

Figure 9: Overall evaluation of Tele-Board and its usefulness for Design Thinking (1 = strongly disagree, 5 = strongly agree).

Discussion

When comparing traditional and digital tools, participants came to different conclusions. Some were very satisfied with the digital environment and claimed that it was even better than the traditional whiteboard and sticky notes. They appreciated that they could easily add digital information and had a digital medium for future uses. On the contrary, other participants stated that the digital tools would slow down their work. In the beginning, this was because they had to get used to the software and hardware. Afterwards, because there was no multi-touch at the whiteboards and only one person could work at a time. They also mentioned that writing on the digital boards is not as fast as writing on traditional whiteboards. However, these disadvantages are mainly due to hardware problems and in a few years they will probably disappear as newer models of digital whiteboards already improved substantially compared to the models we used. Additionally, we could alleviate for example the missing multi-touch problem by providing sticky note devices for every user. This way, all users can contribute their input simultaneously. Some participants stated, they even considered it an advantage that there was one “moderator” who stood at the whiteboard and coordinated the input.

Thus, we have shown that creative work in an all-digital environment is possible and does not influence the quality of the results. Small changes at the interaction design of the software were necessary to improve the ease of use. We already implemented these changes based on our observations and the participants’ feedback. If digital whiteboard hardware now improves, the barriers for digital design work can be removed to a

large extend. However, especially good whiteboard hardware is expensive and hard to move around inside a company. Moreover, digital equipment – particularly the sticky note devices – has to be handled with care: if a paper sticky note pad falls down or someone spills coffee over it, it is not a big problem, for an iPad it is. Furthermore, a lot of people stressed that they like working with paper and getting away from their computers if possible. On the other hand, we learned that people also like to save paper and use digital pictures instead of printing them. Additionally, they appreciate the automatic saving of whiteboard content and the possibility to go back and forth in its "history". Another reason for using the digital tools – as it was stated by users who were rather skeptical – is for geographically dispersed teams because there is no real alternative. With the help of the Tele-Board system it is possible to work synchronously at the same content, and asynchronously with the help of the history function, even if team members are distributed all over the world.

In general, we were happy how well the participants of our experiment could work within the digital design environment. All teams accomplished their work successfully and liked the overall experience.

Conclusion & Outlook

In a five-hour design challenge at five days and with twenty participants we have demonstrated that digital design work is possible and does not disturb the participants in their usual way of working too much. All users saw the main value of a digital environment mainly for distributed work settings. Therefore, in our next steps we will test Tele-Board in a dispersed setup: in a follow-up study between two rooms and in a real-world setting in a corporate environment.

Furthermore, we want to implement and test additional features a digital environment offers. For example, we will (semi-) automatically interpret the whiteboard history in order to make it easier and faster to understand the design work for asynchronously working colleagues. This may also be very valuable for analyzing design work for design research in general (see Gericke, Gumienny, & Meinel (2011) where we already started doing this). We also want to support different design phases, as for example the information synthesis. In interviews, observations and literature reviews, we found that this is especially difficult for novices in design work and that special support could help them getting used to it more easily (Gumienny, Lindberg, & Meinel, 2011).

In general, there is a variety of possibilities to add value to creative work with digital tools and still support the way of working people are used to from traditional tools.

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