Let the Bot Take Care of It: Exploring #CapIt, a Whiteboard Table Capture System

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Abstract. In this paper we describe #CapIt, a system that aims to combine the best of analog whiteboards and digiboards in tabletop collaborations. #CapIt was deployed at an HCI research unit for over a year. In an exploratory study completed after the system was fully integrated in participants' day-to-day work practices, three power users of #CapIt were asked to reflect on their use of the system by means of mindmapping. Using photo elicitation and semi-structured interviews, additional feedback was gathered from the participants. Based on the participants' comments as well as our observations of the mindmapping process, we here report our findings pertaining to (1) hybridity; (2) collaboration; and (3) territories, privacy and temporality; and discuss the influence of the system on collaborative work practices.

1 Introduction

Whiteboards are an often used tool in nearly all types of work, from individual whiteboards in personal offices, to public whiteboards in meeting rooms, to the often digital whiteboards in the front of classrooms. There are several advantages of analog whiteboards that keep attracting people to pick up a marker and draw out their thoughts: whiteboards never have to reboot and never suffer technical failures

(Price et al., 2011), there is no learning curve for using a whiteboard (Gumienny, 2013, p. III), and quick whiteboard sketches support problem solving and reasoning (Larkin and Simon, 1987). As communal whiteboards continue to be frequently used in many workplaces, it is beneficial to research how to best capture, digitize, and share notes from a whiteboard, so that collaborators can easily integrate them into their work practices.

In this exploratory paper, we describe #CapIt, a system that takes snapshots of the notes and sketches on a whiteboard that also functions as a table (see figure 1). The system uploads the captures to the internal messaging system of an HCI research unit. The whiteboard table and its capture system are used regularly for, e.g., collaborative ideation sessions, team meetings, and project progress updates. We illustrate how the characteristics of an analog whiteboard, paired with the affordances of a table, and combined with an already familiar messaging and archiving system, influenced collaborative and creative meetings at the research unit. The findings described in this paper relate to (1) the hybridity of the system in terms of digital vs. analog, but also horizontal vs. vertical; (2) the effect of the system on collaboration, relating to the type, significance and sharing of notes; and (3) a category that encompasses three interlocking themes: territories, privacy and temporality.

Figure 1. Left:The Whiteboard Table, as it is placed in the Center for HCI, spans 600×120 cm, and is surrounded by ~ 12 chairs at any given time. Right: a generic team meeting around the whiteboard table. © David Fisslthaler.

2 Background

To frame our research, as well as the #CapIt system, we will briefly discuss existing research about (collaborative) work on (electronic) whiteboards, as well as research about large, communal table tops.

In many work domains, the use of whiteboards continues to be universal. In the fields of design, architecture, engineering, and computer science, sketching and diagramming is a well-established practice (Walny et al., 2011). In this section, we will discuss the theory behind the use of (digital and analog) whiteboards and

whiteboard capture systems, of which there are many. We will also discuss the characteristics of tabletop collaboration, and how territoriality in shared work spaces influences work practices.

2.1 Whiteboard Note Taking

Content on whiteboards helps externalize thoughts, so they can be more easily understood by others, and supports exploring ideas, without taking decisions too quickly (Cherubini et al., 2007; Triplett, 2016). Whiteboards are used both independently or collaboratively, and synchronously or asynchronously (Tang et al., 2009). In asynchronous use, users of the whiteboard leave notes, sketches and diagrams behind for themselves or others to work on (Mangano et al., 2015). Content on a whiteboard is easily revisitable, updatable, and flexible, allowing users to build representation of information for many types of collaborative and individual activity (Tang et al., 2009).

2.2 Electronic Whiteboards

Electronic whiteboards are popular due to their capability of combining the properties of an analog whiteboard with other (digital) teaching tools (e.g., showing videos or 'undoing' and 'redoing' steps). However, electronic whiteboards can lack resolution (Branham et al., 2010), and they are often turned off to preserve energy (Huang et al., 2006), which causes them not to be *'ready-to-hand'* (cf. (Heyer and Brereton, 2010)), a requirement for skilful, flowing use. Analog whiteboards are therefore still often used by researchers, designers and engineers to understand their own work, as well as communicate it to others.

2.3 Sharing Whiteboards

Communally shared analog whiteboards face the problem of ownership, i.e.: sketches and notes created on a public whiteboard are at risk of being wiped out by an external party (Price et al., 2011), causing people to write notes like 'do not erase!' on whiteboards (Saund, 1999). This results in some notes remaining on the whiteboard for very long times, due to externals' fear of removing important work, and thus rendering the whiteboard useless (Ju et al., 2007). Additionally, it is hard to digitize the notes for archiving purposes: rather than copy the notes by hand by means of a text processor, whiteboard users can often be seen taking cell phone pictures of the whiteboard, for future reference (Inie and Dalsgaard, 2017). Photographs of whiteboards are often used to solve disagreements and to confirm action points (Walny et al., 2011), but to effectively do this, the photographs need to be shared with the entire group involved in the meeting by the person who took them.

Due to practical considerations, it is also rare to see more than two persons writing on the same whiteboard at the same time, as space generally does not allow

for it. When multiple people write on a vertical whiteboard, the overview and communal understanding of what is happening on the whiteboard is lost quickly.

2.4 Capturing Whiteboards

As common as whiteboards are in office environments, so are smart phone snapshots that try to preserve the outcomes a creative, collaborative session on a shared whiteboard (Klokmose and Bertelsen, 2013; Branham et al., 2010).

Varona-Marin et al. (2018) recently analysed the curation of manually captured photos of the whiteboard after the meeting has ended. They found that snapshots of the whiteboard usually serve as general meeting records. Even though only a single group member usually takes a photo of the board, the captures were perceived by the users to be collectively owned by the group members. The captures were often shared via email, or stored in shared folders.

In general, captures of whiteboards seem most often revisited when either participants in a meeting differ on a decision made during a meeting, or when sketches, notes and diagrams made during a meeting need to be digitized to be used in further work (such as reports and presentations) (Walny et al., 2011).

2.5 Working on Large Table Tops

Large tabletops invite more explorative or playful interactions with objects on a tabletop (Zagermann et al., 2016). Tabletop collaboration increases the awareness of the actions of other participants (Rick et al., 2011); it equalizes the roles of the participants (Marshall et al., 2008); it encourages more cohesive work (Rogers and Lindley, 2004); and resolves bottle necks (Tang, 1991). A key goal of collaborative work is often collaborative sensemaking: bridging gaps in understanding between people (Wallace et al., 2013). People working on complex projects tend to externalize key aspects of their sensemaking process, to literally and physically 'lay out the evidence' on table (Andrews et al., 2010).

2.5.1 Tangible Objects

Large spaces support more explorative interactions, involving fidgeting or playing (Zagermann et al., 2016). Wall-mounted whiteboards – both digital and analog alike – offer little space for tangible objects to come into play. Artifacts like paper, pens and other peripherals are primary tools for explaining, developing and communicating ideas during early phases of design (Klemmer et al., 2001). These kinds of objects often act as placeholders in the early stages of design (Smit et al., 2016), functioning as *scaffolds* (Jaasma et al., 2017) or *traces* (van Dijk and Vos, 2011), to support the designers in their process of exploring, extrapolating and communicating. Large, horizontal surfaces more practically allow for interaction with physical, three-dimensional objects, which can support collaborative sensemaking processes (Hummels and van Dijk, 2015). The table surface is an important resource for collaboration mediation; and the spatial orientation of the

participants in relation to each other and the drawing plays a role in the structure of the activity (Tang, 1991).

2.5.2 Orientation

Orientation is critical to how people comprehend information, coordinate actions with one-another, and mediate communication. Orientation plays a major role in informing collaborators who is currently using or reviewing which items, and which items are available. Collaborators often rotate items on a table partially (i.e., sideways) to share the item with others and invite immediate collaboration (Kruger et al., 2004).

2.6 Territoriality in Shared Workspaces

Collaborative work on a shared surface also introduces with so-called *territoriality*: tabletop territories serve to coordinate tabletop interactions (Scott et al., 2004). Territories help people coordinate tasks and create mutual understanding, and so their establishment is crucial in the beginning of a collaborative task (Klinkhammer et al., 2018). Collaborators around a table automatically define personal territories for themselves, in which they collect items and do work that relates only to them. Although never explicitly discussed, collaborators hardly ever venture into another person's personal territory (Scott et al., 2004). Participants may even ask for explicit permission to add to, or adjust items in another person's territory, even if those items are not personal (Morris et al., 2010).

If no personal territories are established, conflicts may arise (e.g., because participants interact with materials that 'belong' to another person) (Pinelle et al., 2009). Personal territories generally reside along the edge of the table, in front of the respective participant (Klinkhammer et al., 2018), group territories take up the remaining space on the table (Scott et al., 2004). Workspace territories are not static states, but instead change shape following the flow of the collaborative process (Klinkhammer et al., 2018).

2.7 Previous Whiteboard Note Capture Systems

In the following sections, we will describe previous works that involve whiteboard note capture systems. Each of the works discussed presented findings that relate to the use of our #CapIt system.

An early adoption of a whiteboard capture system is the ZombieBoard (Saund, 1999). This work featured a pan/tilt camera that would construct a high-resolution capture of a whiteboard by *mosaicing* several pictures together seamlessly. The capture was then automatically printed. The researchers found that a privacy blind, installed in front of the system's camera to obstruct the camera's view, was occasionally used.

Zhang and He (2003; 2004) describe a system for scanning whiteboard content by means of a digital camera. In this system, entire meetings were captured on

video. Even when use of the whiteboard was not required for the meeting, people still turned on the capture system, mainly to capture who was speaking (by writing the name of the speaker on the whiteboard) so that meeting segments could be recognized and retrieved more easily later on.

Holmquist et al., (2003) introduce Total Recall, in which the user holds a hand-held computer with screen up to the board and moves it around to recover previous notes taken on that area of the whiteboard. They argue that this solution provides a better coupling to the whiteboard notes than viewing a capture of the whiteboard on a desktop system.

Price et al. (2011) used wireless-enabled digital cameras to take pictures of students' personal whiteboards, that they used in class. Those photos were then uploaded to a photosharing website. They found that students would diligently label and organize their whiteboard pictures for later use. Additionally, students began to correct the solutions on their personal whiteboards before capturing them, ensuring that a capture showing the correct solution to a problem was uploaded.

Branham et al. (2010) describe ReBoard, a system that focuses enabling detailed search within the collection of whiteboard captures. The search function of ReBoard was based on general date ranges, thumbnails and general location of a sketch on the whiteboard. They found that users shared captures either through the system or via personal email, or that the images were sometimes printed to share with others.

3   Research Objective

In this exploratory paper, we describe the use of the whiteboard table in combination with the connected capture system, that automatically uploads whiteboard captures to the messaging system used in the workplace this exploratory study took place in. The system that we present, #CapIt, combines the advantages of the horizontal orientation of the whiteboard table, the ease-of-use of analog whiteboards, and the archiving capabilities of digiboards. Therefore, our research focuses on the use of the whiteboard table capture system in collaborative settings, and the advantages of the table's horizontal orientation and the system's connection to existing digital infrastructure.

4   System

At the Center for Human-Computer Interaction in Salzburg, a multidisciplinary team of 30 researchers investigate HCI problems. One of the tools they use for this, is the whiteboard table: a structure of 600×120 cm, comprised of two horizontal whiteboards (300×120 cm each; see figure 1). The researchers of the Center use this table on a daily basis, both for collaborative, as well as individual

work. The researchers of the Center also use Slack[1] as their main means of digital communication. Slack offers public and private chatrooms called 'channels' (e.g., *#channel*) as well as a direct messaging system for one-on-one and group conversations. Files, such as photos, can also be shared in Slack. Users of Slack are encouraged to create their own 'bots' to automate processes for them. Bots can do many things that human users of Slack can also do, such as sending messages and sharing files.

To combine the unifying power of the whiteboard table with the easy sharing of files and messages in Slack, #CapIt was created. #CapIt is a system that captures notes and sketches made on the whiteboard table with the press of a button. The captures would then be uploaded in Slack by the *@whiteboardbot* to the *#whiteboardchannel* (see figure 2), where users could review, download and share the photos that were taken of their notes.

As early as 1988, research showed that one major reason that groupware (interactive software and hardware in the workplace) fail, is because they ask more time and energy from the users, than they are getting in return (Grudin, 1988), and still, groupware often fails be the systems are too complex or badly designed, and it's easier for the user to avoid using them altogether (Korpelainen and Kira, 2013). #CapIt was therefore designed with simplicity of use in mind, integrating the capture system fully with the messaging system that the future users of #CapIt were already using. The system is designed in a rather open-ended fashion, so that users may interpret the system in ways that we, as the designers of the system, could not have fully foreseen (Pipek and Wulf, 2009), in hopes that the users appropriate the system in a way that most effectively and efficiently supports their work day.
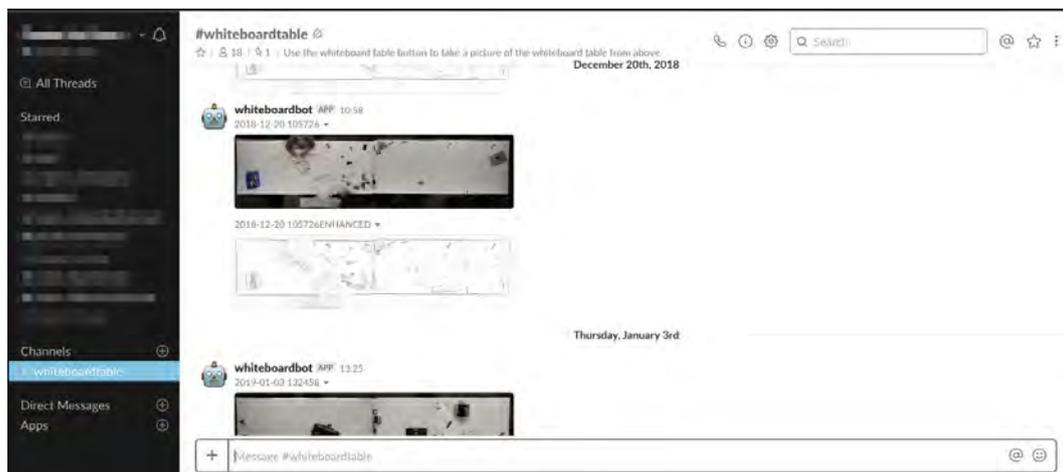

Figure 2. The *#whiteboardchannel* in the Slack work space, where the captures of the whiteboard table are uploaded for the researchers of the Center for HCI to use.

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[1]   https://slack.com/

Figure 3. A typical picture as taken by #CapIt. In this picture, one can see the type of notes taken during meetings and creative sessions, but also the presence of other, tangible items, including: basic whiteboard table necessities (markers, wipers); technology (personal computers, phones, chargers); and peripherals (snacks, water glasses, coffee cups).

4.1 Technology

To capture the entire length of the whiteboard table with a high enough resolution to maintain legibility of small, handwritten notes, we needed a minimum of 25 points per inch[2] (PPI) (Zhang and He, 2004). The PPI can be calculated by dividing the diagonal resolution of a picture by the diagonal size of the subject (in this case: the whiteboard table) in inches (in this case: 241"). This leaves us with a minimal resolution of 1182×5908 pixels – more than 4K resolution. Therefore, the final iteration of #CapIt makes use of *two* 4K cameras, the images of which are stitched together. These two cameras are mounted 2 meters above the whiteboard, and connected to a ODROID-XU4 single board computer[3], by means of two USB 3.0 ports. The cameras are triggered by a Logitech POP button[4] (see figure 4). This button sends a signal via Bluetooth Low Energy (BLE) to the ODROID board. Once the pictures have been taken, they are stitched together (see figure 3) and uploaded to the public *#whiteboardtable* Slack channel, where users can find, download and share the pictures of the whiteboard table.

Figure 4. The cameras above the whiteboard table are triggered by this white Logitech POP button, which was placed in a black, laser-cut casing (whiteboard markers for scale).

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[2]   1 inch (1") $\approx 2.54 cm$

[3]   https://www.hardkernel.com/shop/odroid-xu4/

[4]   https://www.logitech.com/en-us/product/pop-smart-button

5 Study Setup

#CapIt has been in place at the Center for HCI for more than a year, during which employees have freely been making use of the system. All pictures (n = 168) that were shared in the *#whiteboardtable* channel in Slack during the period of 21 November 2017 to 21 November 2018, were downloaded. 79 Pictures were discarded for being outside the scope of research (e.g., duplicates or pictures that were taken in quick succession after one-another, pictures that did not show any notes, or pictures that were taken during prototyping and testing phases). This resulted in a data set of 89 pictures.

5.1 Participant Selection

From the dataset, in which 17 different users of the system appeared, we identified three so-called 'power users': the users that appeared most often in the pictures. For this study, the three power users appeared in 18, 13, and 12 pictures respectively. We identified users not only based on appearance (i.e., clothing, posture), but also on personal items, such as: stickers on laptops, headphones, handwriting in the notes, personal water bottles, and notebooks, which were visible in the photos. In 25 pictures, no user could be indubitably discerned.

5.2 Generative Tools

During the study, we followed an approach developed by Keller (2005, p. 23-27), who used techniques from the field of participatory design to elicit responses from experts about their methods of collecting and structuring inspirational material. Keller (2005) employed generative tools (2000). Specifically, participants were asked to create three mindmaps relating to the way the participants structure their collections of creative and inspirational material.

The three power users were invited for a collaborative mindmapping session that served to learn about their use of the whiteboard table documenting system. By allowing for visual expression of the participants in the mindmaps, rather than just verbal expression in a semi-structured interview, we hoped for more diverse insights shared by the participants (Keller, 2005, p. 23). Different from Keller's method, we opted for a collaborative session, as #CapIt is mostly used in collaborative sessions. Participants, therefore, are used to sharing the space on the whiteboard table with others, and collaboratively create notes.

By inviting the participants to *use* the system, with the goal of exploring and studying the use of the system, we hoped to inspire the participants to share recursive feedback, in a dialogue not just with the researchers, but also with the system.

5.3 Participant Driven Photo-Elicitation

To start a dialogue about the effect of #CapIt on the work of the participants, the researchers opted to begin the interview section of the study with a participant driven photo-elicitation session (Harper, 2002; Van House, 2006; Gorm and Shklovski, 2017). Photo elicitation has been shown to help participants focus on the interview, and to make new associations (Carter and Mankoff, 2005). Before the study, the participants were asked to send the researchers the most interesting picture they had taken with #CapIt. The researchers then edited these pictures to remove anything that wasn't a note or sketch (see figure 5). The participants were asked to explain what stood out to them about the edited photos. Then, the unedited photos were shown to the participants, and they were asked to compare the pictures and comment on the differences.
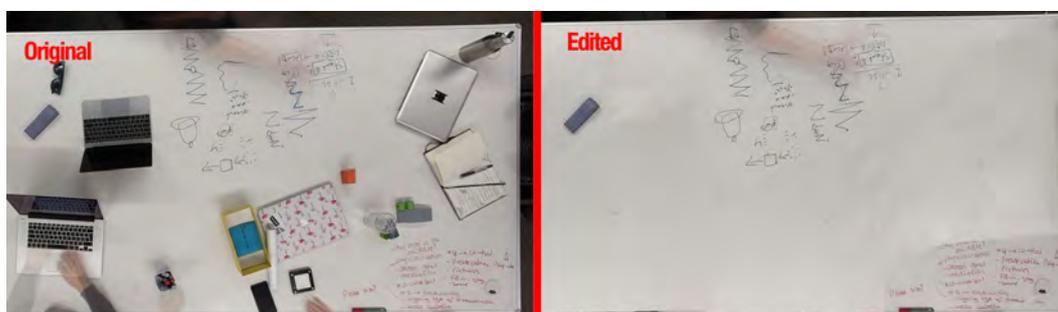
Figure 5. The pictures that the participants had sent to the researchers were edited to remove anything that would not be on a 'normal' (vertical) whiteboard. Left: part of the original picture that P1 sent in. Right: part of the edited picture.

5.4 Semi-Structured Interview

Directly following the photo-elicitation process, the researchers transitioned into a semi-structured interview that touched on the use of the whiteboard table; the capture system; and the sharing, archiving and sensemaking of the photos. Although questions were prepared for the interview, they were not asked sequentially, but rather guided the interview while keeping the flow of the conversation intact.

6 Data Collection & Analysis

Two researchers involved the development of #CapIt were present during the entire study. The primary researcher guided the mindmapping, photo-elicitation and interview sessions, while taking notes. The secondary researcher was responsible for monitoring the recording equipment (a GoPro Hero 6 recorded the entire session, while the semi-structured interview was additionally recorded on a smartphone), and took notes as well. #CapIt itself was used to intermittently capture progress of the mindmapping on the table.

The notes of both researchers were digitized and merged in one document. These notes included observations of the participants, Both researchers then, independently, engaged in descriptive coding of the study notes (Saldana, 2009, p. 6). These two separate sets of codes were then compared, and the notes were categorized based on the codings. From these categories, ten overarching, often interconnected themes were derived. They are described in the findings.

The mindmaps that were made by the participants during the study were captured by #CapIt (see figure 6). While the specific content of the mindmaps themselves were not extensively archived, we analyzed the process of making them, and their outcomes, based on #CapIt captures and research study notes.

Figure 6. The three mindmaps that were created by the participants during the study. From left to right: 1) the first mindmap about the general use of the whiteboard; 2) an attempt at structuring the initial mindmap in terms of users, purpose, role, use, and end goal; 3) a more specific mindmap about the physicality of the whiteboard table, and the accompanying capturing system.

7   Findings

In this section, we will describe the most interesting findings from the study by means of describing the overarching themes that were found during the analysis of the study results.

7.1   Choice of Picture

An immediate interesting finding is illustrated by the choice of pictures of the participants. Only P1 submitted a 'standard' #CapIt picture; i.e., the type of picture that is most commonly captured by #CapIt, including meeting notes and to-do-lists. She mentioned that she had chosen this note as an example of how she would refer back to a #CapIt picture, when she had not taken notes in her personal notebook during a meeting.

P2, on the other hand, submitted a picture that was taken during a creative workshop with children in the context of a research project. She mentioned that she not only took the picture as documentation of what had taken place during the workshop, but that the picture also perfectly served the purpose of sharing their progress in external presentations, as faces are not visible in the picture.

Finally, P3 submitted a very old picture, that she had saved somewhere in her personal files, and named *'Data_Analysis_Observations.jpg'*. She clarified that this

was the picture that she most often referred back to, as it contained the entire data analysis of a project she was working on. She mentioned that she had even forgone making a spreadsheet on her computer, but had instead saved this capture to the Data Analysis folder on her computer. According to P3, the collaborative process of data analysis on the whiteboard table started quite chaotically, but by being able to all work on it collaboratively, and by being able to erase and rearrange items easily, it became a structured overview.

Figure 7. P1 submitted a picture of a recent meeting she took part in. Although she did not write any of the notes on the table herself, she explained that this picture was important to her, because she did not take any private notes in her notebook during the meeting, and went back to it several times to recall what steps were agreed on, and what her tasks were.

Figure 8. P2 chose a picture taken during a creative workshop with children, which took place in the context of a research project. She chose this picture, not so much for the content in it, but for the message that is conveyed with it. She has used the picture several times in presentations for external parties, to explain the kind of work she does within this project.

7.2 Type and Significance of Notes

The participants were asked their first thought towards 'working on the whiteboard-table'. P1 (designer) mostly associated the whiteboard table with drawing, while P2 (designer) generally used in to explore thoughts, both in groups and individually. P3 (sociologist) said to mostly associate the whiteboard table with data analysis. The responses of the participants show that #CapIt is useful for a range of different activities, and for people with different backgrounds. Captures reviewed for this study included not only meeting notes and brainstorming sessions, but workshop progress, physical prototyping sessions, artistic drawings, data analysis, time lines and schedules, etc.
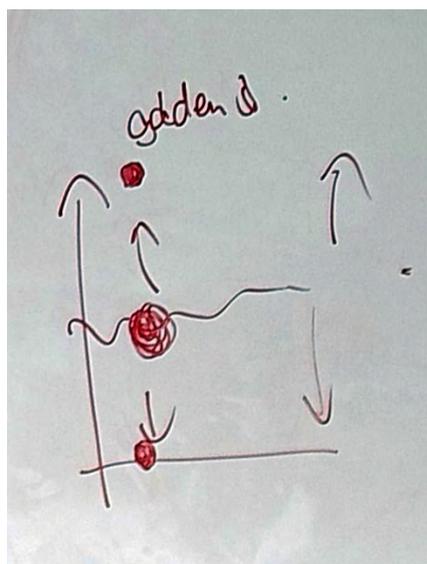
Figure 9. P3 found a picture that she had saved to her personal collection on her computer for future reference: a photo of the whiteboard table after an intensive collaborative data visualization session. Note: this picture was taken with an older version of the system, hence the lower quality image.

Participants noted that when they come across notes from others on the table, they can generally deduce significance (P2: *"From the way the notes are written down, I can decide if they're important"*). They mentioned that they would generally not delete things that had colleagues' names attached to them, or things that were appropriately titled (P2: *"Stuff with titles like 'Data Analysis', I would never delete"*), unless they absolutely needed the space to work on. In those cases, P2 and P3 would capture the work before erasing it, while P1 said that she would then rather not work on the whiteboard table.

Although the participants mention that they think they can generally deduce the importance of notes and sketches from their appearance, P3 also reported on an instance where a colleague drew a simple scribble during a project meeting to illustrate an epistemological point (see figure 10). Although this colleague never meant for the sketch to be saved, it became a guiding visual keepsake for P3, to remind her of the main objective of the project.

7.3 Roles & Collaboration

Right from the start of the mindmapping session, dividing roles was noted as an important step in the use of the whiteboard table (P3: *"Maybe we should divide colors* [of markers]*?"*), especially after it became clear that a lot of terms appeared several times in the mindmap (P3: *"We are reproducing a lot of stuff: we need roles."*, and "[In a normal session] *we would have decided: who will write?"*). The participants mentioned that in meetings with a collaborative goal, there is generally

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Figure 10. A seemingly innocuous scribble, that came to play an important role in the stucturing of a complex project.

one person taking on the main writing task, with others adding on where needed. In meetings during which people have their individual tasks and goals people tend to write their own, personal notes, in their personal territory.

7.4 Structure

During the study, the participants started out with an unstructured brainstorm (see figure 6, left), calling out and writing down whatever came to mind when thinking of #CapIt. Nonetheless, the first mindmap ended up having multiple entries of the same term. Realizing that they could not reach sufficient structure in the current mindmap, they decided to create a new mindmap on the other side of the table. Whereas the first mindmap had the characteristics of a word web, the second mindmap took the shape of a flowchart or schematic. The participants found themes in the original mindmap, and structured them under the headers of: users, purpose, role, use, and end goal (see figure 6, middle). Finally, the third mindmap resembles a chart, in which the participants tried to map characteristics of the system to physical versus digital components (see figure 6, right).

7.5 Orientation

As any horizontal shared workspace, the whiteboard table faces issues of orientation of content. P3 even mentioned that she has become very skilled at writing upside-down. The participants noticed while making the first mindmap, that a lot of the duplicate terms were written in different orientations (i.e., the participants might have noticed the term if it had been written in the 'correct' orientation). This resulted in the decision of the participants to sit on the same side

of the table while making the second and the third mindmap (P3: "*If we're on the same side, it's easier to share note-taking* [tasks]". Furthermore, the participants switched seats twice while making the first mindmap, to have a look at the mindmap from the other participants' perspectives.

7.6 Effects of Removing Peripherals

Once the peripherals were removed, the difference in the type of pictures that the participants had brought along for the study, became all the more clear. Whereas the focus of P3's picture is fully on the notes that are written on the table, the picture that P2 has brought completely loses all meaning when the tangible workshop materials are removed. In this picture, the tangible materials on the table play a bigger role in the activity going on around the table, than the sketches on the table themselves.

In the picture that P1 brought, removing the tangible objects on the table did not change the meaning of the notes, however: the ownership of the notes (i.e., the personal territories of the participants) could no longer be identified, due to lack of personal items on the table. Additionally, the main subject of the meeting – a yellow box, seen in the middle of the right table in figure 7 – was also removed, making it more difficult to recognize the capture at a glance without reading the notes in the image.

7.7 Trust in the System

P3 noted that whenever she takes a picture of her work on the whiteboard table, she checks the *#whiteboardtable* channel in Slack to see if the picture is there, before erasing her work. The other two participants noted that they did not do that: they trust the system. We suspect this to be a result of P3's use of a prototypical version of #CapIt. The reliability issues of this version of #CapIt may have led P3 to believe that the system lacks functionality or predictability, and that the system therefore cannot be trusted (Thatcher et al., 2011). Rather than discontinuing the use of the system, she instead decided to always check that the system behaved according to her intentions. P1 and P2 only every experienced a fully functional system, and therefore did not experience any disconnect between system expectation and system confirmation (Bhattacherjee, 2001) and did not feel the need to double-check on the system's performance.

7.8 Temporality vs. Permanence

The system causes tension between temporality and permanence. All participants viewed notes on the whiteboard as a work-in-progress (P2: *"It is kind of like real-time editing"*; P1: *"I can always take it back"*): participants felt less need to prepare or structure their thoughts before writing them down, than for paper note-taking – which is shown to stimulate creativity (Diehl and Stroebe, 1987). However, the addition of #CapIt with its automatic upload to a public Slack channel, introduces a layer of permanence to scribbles and sketches (P2: *"You cannot press a button*

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to delete a photo. Once it's taken, it's out there"). Capturing the notes therefore takes a way the "erasability" that is a defining quality of whiteboards. P3 noted that she often cleans up her notes and sketches, and removes peripherals from the table, before pressing the capture button (cf. Price et al. (2011)).

7.9 Territory

As in other work, we also noticed that personal territories are quickly created on the whiteboard table. All participants shared the habit of writing small, personal notes (such as to-do lists or reminders) on the edge of the table, whereas communal note-taking happens collaboratively in the middle of the table. The personal territory on the whiteboard was classified by the participants as being somewhere between a personal notebook (completely private), and the center of the table (P3: *"It's a big table, you're not always in control of what people write and especially what they erase"*).

7.10 Privacy Concerns

Mounting cameras in office spaces always come with concern for individuals' privacy (Saund, 1999; Branham et al., 2010). Combined with an automatic uploading system, that shares the image in a channel that is accessible to approximately 30 people, the issue of privacy regularly came up in the interview with the power users. All participants agreed however, that anything written on the whiteboard table and not immediately erased, should be considered public knowledge (P3: *"If people leave stuff up for days, it can't be NDA anymore"*). When P1 mentioned that she would not feel comfortable taking pictures of other people's notes that have been left on the table, P2 and P3 both affirmed that they would take captures of other peoples' notes before erasing them, to ensure that they did not delete any important work.

8 Discussion

In this section, we will discuss implications of the findings from the study, as well as the significance of some of the researcher's most interesting observations. The themes that were described in the findings, and the relations between them, will be discussed below.

8.1 Hybridity

#CapIt introduces a hybridity that has, to our knowledge, not yet been described in literature. Capture systems for vertical whiteboards exist aplenty (see, e.g., Fakih (2012); He et al. (2003); Zhang and He (2004); Varona-Marin et al. (2018)), as do interactive whiteboards (see, e.g., Saund (1999); Rebecca et al. (2015). On the horizontal front, there are many examples of interactive tables (e.g., Wallace et al.

(2013); Zagermann et al. (2016); Rogers and Lindley (2004); Rick et al. (2011). #CapIt, however, combines the advantages of an analog whiteboard (foolproofness), with the advantages of a digital whiteboard (archiving), and those of horizontal surfaces (face-to-face collaboration and interaction with tangible objects).

These characteristics lead to unique interactions between the physical and the digital. For example, we expected that participants would depend on the capture date of the picture and the (written) notes (Branham et al., 2010), to discern which picture was of importance to them, but we actually noticed that **users of the system use physical peripherals (personal notebooks, smart phones, even people's hair colours and clothing) to recognize pictures**. Removing the tangible objects from the picture, such as can be seen in figure 5, also removes the context of the picture to a large extent.

Furthermore, we often noticed that **physical objects were often part of the activities taking place on the whiteboard table**, as can be seen in figure 8, where the tangible objects play the main role in the picture, and in figure 7, where a tangible object (the yellow box) provides the context of the picture, and the meeting that took place.

That tangible objects are important for creative, collaborative work is not new information (van Dijk and Vos, 2011). However, we found that **some qualities of these tangible objects appear to also translate to, and even enhance, purely digital content in a different context** (i.e., on a computer or screen, *after* the meeting).

8.2 Collaboration using #CapIt

We found that the whiteboard table in conjunction with #CapIt invites many different modes of use, for many different types of collaborative work. **For collaborative work that takes place in the shared territory of the whiteboard, the orientation of notes, sketches and physical objects is very important**, whereas the orientation of personal notes in the personal territory only matters to the person taking the note. The system also seems to increase the feeling of control over the shared territory of the whiteboard table, because although anyone can add and erase notes, everyone is also free to take a snapshot, so that nothing is lost.

The finding that importance of notes was not always immediately acknowledged, e.g. Tang et al. (2009): the meaning of sketches and notes can evolve over time, transforming from situated, contextual drawings into personal reminders, communication aides, brainstorm starting points, etc. The direct connection between the whiteboard table and Slack becomes important here: participants may not normally have taken the time to copy down the notes and sketches in their own notebooks, but **it is hardly any effort to hit the capture button at the end of a meeting**. Even if participants do not believe that there is anything worthwhile in the notes, they will still have it archived in the *#whiteboardtable* channel, just in case. #CapIt accordingly provides a press-of-the-button back-up system for its users that is readily available to all

participants at all times. We believe that this **continuous availability and the ease of use are a large part of the success of #CapIt** and any other type of collaborative work support system.

8.3   Territories, Privacy, and Temporality

The themes of privacy and territory also strongly interacted with the theme of temporality versus permanence. Whereas others describe that whiteboard capture system often lead to privacy concerns regarding the content of meetings (Saund, 1999; Branham et al., 2010), the participants in this study were **primarily concerned with their personal territories, and the interplay between a very temporary note on a whiteboard, and a very permanent capture**, that is public for everyone to see. The physical capture button – combined with the sound effects the system makes – eases some concerns: it is not possible to covertly take a snapshot of the contents of the whiteboard table.

Furthermore, one participant reported that she would not take pictures of others' work, which is a surprising finding, as there is no indicator as to who took a picture: **the ownership of the picture is shared between anyone who can access the *#whiteboardtable* channel**. However, for some users, the territory of the person creating notes and sketches on the whiteboard table remains with those notes, until they are removed by the person who created them.

#CapIt was not subjected to the strong feelings about privacy that other systems have been. This is likely related to the fact that the system was implemented in an open office structure, where the expectation of privacy is already low. It may also be a sign of developing times, in which privacy cannot be assumed, with or without a system like #CapIt present. In any case **the acceptance of the system in terms of privacy may be heavily dependent on the spatial context of the system**.

9   Conclusion

In this paper, we have described an exploratory study regarding a whiteboard table capture system, that took place at an HCI research unit. Three power users were asked to make mindmaps using the system, followed by a photo elicitation session with captures from the system, and a semi-structured interview. Ten themes were defined in the findings, that connected into three categories that were described in the discussion: the hybridity of the system; the effect of the system on collaboration; and a category that encompasses three interlocking themes, namely: territories, privacy and temporality. #CapIt has been organically embedded into the work practices of the researchers at the HCI research unit, and the captures often find their way out of the *#whiteboardtable* channel into the day-to-day business of the users of the system, even (long) after meetings around the whiteboard table have concluded.

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