Asynchronous Understanding of Creative Sessions using Archived Collaboration Artifacts

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***Abstract*—To a large extend, collaboration and communication consists of the understanding of extrinsic activity. This task is especially hard to achieve in remote settings or also locally when people cannot take part in meetings. In this paper we are addressing the question, if understanding of the essential decisions, facts, and processes can be achieved by just consuming collaboration data afterwards. Therefore, we take existing experiment recordings and make them explorable by the TeleBoard History Browser. Participants had a given time frame to answer content-related questions for a design thinking session.**

We found out that people are able to review those creative sessions and grasp the essential key points in the past work processes. Still, people are approaching the data differently depending on their personal preferences and their general process knowledge. It turns out that our approach can help distributed teams in working closer together beyond conference calls or shared documents. From our perspective, traceability of past interactions can substantially ease remote collaboration, especially in creative settings.

***Keywords*—understanding collaboration; asynchronous collaboration; history; digital whiteboard**

I. Introduction

The area of collaborative processes has been elaborated from very different perspectives during the last decades. When it comes to tools, the CSCW classification published by Rodden in 1991 [25] still fits most of them. The nature of collaboration - especially in professional environments - is increasingly distributed, which goes hand in hand with an increasing degree of asynchronous work, because e.g. time differences make it difficult to jointly work at the same time.

Our approach especially focusses on the area of asynchronous understanding of past processes. The main intent is to not artificially add information to the history data which was annotated by experts, but present the data as is by highlighting important information. Therefore, we want to answer the question, which parts of the archived data might be more relevant than others.

II. Related Work

We grouped the related research into three different fields. First, as there is no one-fits-all definition of asynchronous collaboration, we try to describe the different facets of it. Furthermore, as to our understanding, asynchronous work consists largely on the understanding of past interaction, which was often taken out synchronously, we also looked into typical barriers for understanding past interaction processes. Our approach consists of a combination of digital whiteboard data with video capturing. We therefore outline existing approaches of whiteboard data capturing and the role of video for asynchronous work comprehension.

A. Defining asynchronous work

Rodden states in [25] ”Cooperative systems are [..] either synchronous or asynchronous systems.“. We would like to add ”at the same time“ to this sentence. There are systems that can be used in both ways and to our understanding this is an essential factor to be highlighted. Tools that allow to switch between sequential editing and real-time cooperative editing became very popular in the last decade (e.g. Google Docs[1]).

In [23] Molli et al. define synchronous, asynchronous and multi-synchronous working modes, meaning synchronous as ”working at the same time on the same data“, asynchronous as ”members work at the same time or postponed on the same data“, and multi-synchronous ”each member has a copy of the shared data. They modify their copies in parallel“. The second case comes close to our definition of asynchronous work. We leave out the multi-synchronous part as it would result in merging activities, which we want to prevent.

Wikis and forums are classical examples of tools allowing asynchronous working modes. Those tools are primarily intended for working at the same content at different times, while mostly locking for synchronous modification of content. There are methods to facilitate traceability in those systems, e.g. quotations of previous forum posts so that references to existing content can be made.

From our perspective, asynchronous collaborative work has to combine two different aspects: a possibility to understand past (often synchronous) collaborative processes and modification of the data results in a potentially synchronous session with the possibility of other participants joining the session, easing continuation of existing content.

Our implementation of such a system is shown in section III-A. We aim at building a system that encompasses every

[1]http://docs.google.com, now consolidated within ”Google Drive“

dimension of the CSCW matrix [25] within the same tool and thereby soften the borders between these dimensions.

B. Barriers in understanding past work processes

Manohar et al. [19] describe a scaffold for asynchronous interaction with synchronous sessions. The main goals described are: (1) consistency of the replay, (2) users must be able to successfully collaborate by exchanging, editing, browsing and interacting with the session recording, and (3) desirability to find moments of interest.

Barksdale et al. present an interesting approach in [2], where workgroups are enabled to have asynchronous video communication using the metaphor of threads to connect the video items in a visualization interface. One downside mentioned is that it is "difficult to quickly seek to a specific point in the video". This becomes even more problematic, when videos are longer than short video notes, but entire sessions of multiple hours.

Koh [18] states, using digital whiteboards is still difficult in practice. The major problem of the limited adoption is not only the price, but more general: "they lack resolution, they are often turned off to save power, they have technological dependencies [..]". Alternatives often is the capturing of traditional boards, which then leads to loss of detail in the temporal dimension (cf. [3], [10]). The benefits of digitalizing content can hardly compensate for the deficiencies.

Bargeron et al. [1] elaborate on video material as a medium for asynchronous communication in the fields of on-demand training and education. It is a system for having a video stream combined with a slide stream. The system uses annotations on the slides to emphasize points that are mentioned in the video.

C. Areas of application

There are many examples of systems in which asynchronous video plays an important role. Many of them are located in the area of learning or teaching. Masum et al. [21] and Filippidis et al. [6] show distance learning approaches with the help of asynchronous video. MOOCs (massive open online courses), which are extremely growing in importance over the last years, often face the same challenge of using recorded video to playback a lecture to a student. Grünewald et al. [9] point out that "Interestingly the social features of the platform (forums, learning groups) were not seen as having a positive impact on the learning success.".

Roseman et al. show with [26] a groupware system called "TeamRooms". They describe a set of tools in a room-metaphor for multi-mode collaboration in an online scenario. Therefore one of their requirements is "rooms and their contents must be fully persistent", which is desirable not only for online settings, but also for traditional meeting rooms. In larger companies it is normal to dynamically book meeting rooms. Often, companies try to equip those rooms with equal tools (whiteboards, tables, video conferencing, etc.), but in practice, a full equality of the physical rooms cannot be achieved. This leads to our overall requirement that a solution has to be as flexible as possible, handling different kinds of situations with different users in different environments.

He et al. [11] use an approach to capture regular whiteboards in order to make the content accessible to a remote party. Klemmer et al. [17] use a hybrid approach with a digital whiteboard to change the digital representation of the content. Although those solutions can do a fantastic job in transferring traditionally created content to the digital world, they both suffer from the same problem: collaborators are not able to edit remotely created content. From our perspective, consequent digitalization is the only valid strategy to overcome that barrier.

Another important aspect of collaboration is presented by Heer et al. [12], dealing with collaboration on data visualizations. Awareness information such as pointing is found out to be extremely valuable to the understanding of the remote side.

As a conclusion of this section, we aim at developing a novel way of interacting with past sessions in order to understand them. We consequently refrain from using an additional layer of data that is not part of the original process, such as annotations, in order to prevent another phase of time-bound interaction with low user acceptance. Delivering an experience that is as unobtrusive as possible [8], the collaborative nature of the features is either hidden (instant synchronization of the whiteboard) or can be activated on demand (pointer transmission).

III. History Browser - application design and implementation

As Roger Martin states in [20] "Neither analysis nor intuition alone is enough. [...] The most successful businesses in the years to come will balance analytical mastery and intuitive originality in a dynamic interplay that I call design thinking.". More and more companies see a competitive advantage in using such innovation methodologies. While developing the History Browser application we targeted this distinct audience. The project aims at supporting creative people that work with an innovation method called "design thinking". The physical project spaces those people use, are different from typical work environments [24]. Besides the workspace, the working mode is also different. To extremely simplify it into one sentence: an interdisciplinary team of about four to six people work an a so-called wicked problem [5] while using a set of methods (e.g. brainstorming) alongside a six-stage process [24]. The nature of the process implies a not necessarily well-structured process. Due to its iterative style, it is only partially predictable which part of a session will be important to a team member being absent from a session and trying to recap and understand a past session. To support the flexibility of the working mode, we wanted to make as little assumptions as possible on the process while technically approaching the overall problem.

History Browser is a web-based tool that basically displays recorded content. So it is just the end of a pipeline of

different steps within the data flow. Tele-Board is the overall project that is a collaborative platform for creative sessions. We designed the Tele-Board suite to be as independent as possible from the working mode. Thus, we wanted to allow people to work synchronously as well as asynchronously. This implicates some kind of session capturing. By not binding the representation of the content to a certain medium, which is mostly achieved by the consistent digitalization, we support working modes which can be anywhere in the broad spectrum between co-located and distributed work.

A. Capturing of the displayed data - the Tele-Board system

Today, whiteboards are ubiquitously used in all offices – in companies of all industries as well as in universities and schools. Problems arise if teams are distributed all over the world and cannot meet easily. Although digital whiteboards are implemented in many online-meeting applications, they often do not fit people's needs and are not used frequently [14]. Tele-Board is meant to be a solution for people who often work at whiteboards, using sticky notes and other tangible tools - such as paper and pens - to visualize their ideas and designs [4]. Additionally, the system shall have all advantages of a digital solution, as for example saving whiteboard states and continuing at another place of work. In contrast to other solutions (e.g. [3], [10]), we do not store image representations of the content but the communication flow itself.

The Tele-Board whiteboard client focuses on the traditional whiteboard metaphor: scribbling on the board and wiping off the scribbles are the elementary functions. Furthermore, the Tele-Board system gives the possibility of writing sticky notes with different devices (e.g. tablets, smartphone, keyboard etc.). By creating the sticky notes digitally instead of capturing paper notes, media gaps and capturing time as in *The Designer's Outpost* [16] can be omitted. For a remote setup, it is possible to open multiple instances at different locations. All actions on whiteboard elements are synchronized between the whiteboard instances, enabling every user to always see the team members' modifications and manipulate all sticky notes and drawings, no matter who created them. This is a major advantage compared to pioneer projects such as *Clearboard* [15] and *VideoWhiteboard* [27] where you can only manipulate your own whiteboard marks.

The general system architecture and communication infrastructure can be outlined as follows: A central collaboration server connects all workspaces and routes communication messages between them. The centralized architecture provides the opportunity to capture all communication data that is exchanged between the clients. Archiving this data gives the possibility to reconstruct the communication afterwards, including every single detail as it has been transmitted in the original message flow.

One challenge was to capture not only all information produced within the system, but also interaction that took place anywhere in the workspace. Therefore, we implemented a video conferencing system that is automatically capturing the conversations on a central server. As there is a connection between an opened whiteboard client and the video session, we can easily assign the recorded video (including audio) stream to the whiteboard session. Putting those different kinds of streams together, we can achieve a broad view on the past session. This could now be presented to a team member that was absent for a day. But nobody wants to watch at hours of video seeing the colleagues discussing and working on problems. Therefore, we faced the challenge of extracting as much information from the archived data as possible.

B. Dimensions of activity analysis

As mentioned before, we had the goal to find out as much about the data as possible, without making too much assumptions on the data and especially the quality of it (such as audio quality). We assume that there is very low probability that people like to document and therefore refrain from using any kind of artificial summary material. The data that is analyzed (and later used for the evaluation) should be created under conditions being as realistic as possible. The overall objective is to point a user of the history browser to states that are more important than others, by not watching at hours of video material, but directly navigating to them.

We developed different metrics, which presumably can give a hint on the importance (worthiness to watch, from the perspective of the person watching) of certain video segments. These measures are designed to allow subjective interpretation from the person watching. As the video and whiteboard data is primarily bound to a sequence of events, we use a temporal dimension as the baseline for all of these metrics:

a) video availabilty: People using the Tele-Board have the possibility to explicitly turn the video capturing on and off, in order to ensure privacy when they do not want to be video taped. This information can also be valuable for the "understander" of a session, as people might want to say "here is something I have to talk about".

b) whiteboard activity: There are always phases of intense and less intense interaction. From a content perspective we can see this in the whiteboard data that is archived in the history database. We discretize the update events in buckets of minutes in order to find out points in time with more or less produced, modified or deleted content.

c) loudness level: In phases of less interaction on the whiteboard, we have the challenge that interaction data is not explicitly in the database. Analyzing the video streams, we found out that taking an averaged measure of the loudness level in the video can give hints on the intensity of a discussion in front of the board, for phases without direct content interaction on the board.

There are more metrics you could think of. After evaluating quite a few, we decided to use the described ones. An obvious example would be speaker detection in order to tell how many

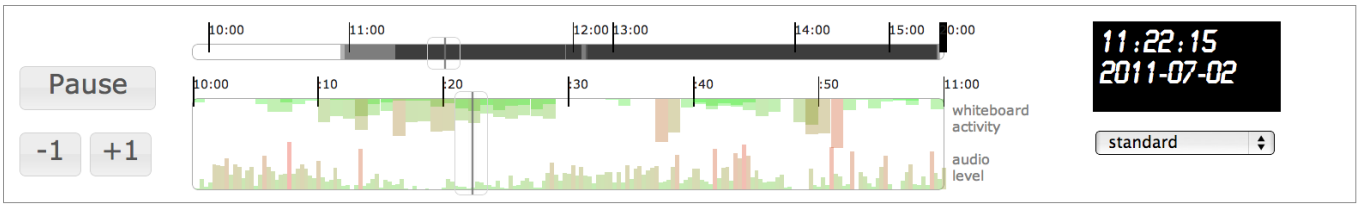

Figure 1: Zoomed screenshot of the History Browser Application slider component: the three different sensor dimensions (from top to bottom): video availability, whiteboard activity, and loudness in the video streams

people were active during a phase, if it was a monologue or a group discussion. For the given video streams, experiments revealed that the audio quality is insufficient for this kind of analysis. This basically comes from the nature of the microphones (built into web-cam) and their position in the center of the room. As we wanted to protect people from being bothered too much by the observation equipment, we e.g. refrained from placing clip-on microphones on the participants, although this could have improved analyses results.

C. Implications for user interface design

With the history browser, we wanted to design a tool, which is easy to use for novices in order to minimize the training time and lower the entry level barrier. Therefore we used existing UI components and traditional UI metaphors in order to enrich them with additional information.

There are basically two regions: The top of the screen is occupied by the time slider bar including an overview slider, a detail slider, a play/pause button and a date time label. The rest of the browser window can be freely used to drag around and resize the whiteboard and video windows. In every session we had two whiteboards in parallel with one camera assigned to each whiteboard. This linkage should be fixed, to minimize confusion. For that reason, video and whiteboard window cannot be separated from each other. As it is very confusing to hear audio material from the two sessions in parallel[2], there is a switch to select the audio stream of one camera at a time.

The essential user interface component is shown in Figure 1. It is the possibility for the user to interact with the data in a time-centric manner. Therefore one has to understand that the whole interface does display exactly one point in time at a time, which is shown in the date and time label on the right side. The main challenge for the user is to find out those points where he or she wants to dive in deeper and watch and listen to a period of the captured session. As there is several hours of video and compared to that only very few time to watch, the user has to easily find moments that are more important than others.

We therefore use two different sliders showing also different scalings. The upper slider distributes time intervals depending on the amount of action. Every second with activity on the board is one step in the slider. If there was activity in few seconds within an hour, this hour will be display smaller. Looking at the time between 12:00 and 13:00 there was only very little activity (because of the lunch break), which is therefore only a relatively short part of the whole slider bar. This slider is not time-continuous and people cannot tell with certainty at which point in time they would drag the upper slider. Nevertheless, participants often intuitively achieved this task quite satisfactory.

The focus+context (or detail-plus-context) idea of visualizing data aims at showing an overview of the complete dataset with low detail (context) alongside a more detailed (focus) view of the region of current interest. Interaction with the visualization allows to dynamically change the region of interest and thereby find details of a different region (cf. [13] [22]). Our implementation of this technique is based on the temporal axis. It is important to see an overview of the whole session. As a detail view, we found out that using an hour of interaction including more detail, is a reasonable interval to display more information annotated on the timeline.

D. Technical realization

The whiteboard data is archived in an XML format within a relational database. As described in [7], the given data structure allows us to easily recreate the state of a whiteboard at a given timestamp. In earlier versions, we used a bitmap image format (e.g. PNG or JPEG) to present screenshots of the whiteboard. Those has the advantage of compatibility with all browsers. The process to create the screenshots takes quite some computational effort (database query, image creation, rendering, transfer to client). For a slider-application, which is demanding for quick response times, it was hardly usable.

In modern browsers, it is much more convenient to display large image content based on vector graphics. Therefore we now create SVG images that can be rendered on the client independent from the screen resolution. The server image creation is much faster now, consisting only of the database query, concatenation of the XML document from the single

[2]Although the videos are synchronized with each other, there is a (minimal) misalignment between audio streams. Pre-Tests have shown that this heavily disturbs users because they perceive a reverb. Occasionally there are delays of about one second, which are barely noticed in the video image (most probable because one can only look at one image at a time), but highly distracting for the audio stream.

elements, and a transformation based on XSL to create the final SVG-compliant document, which is then delivered to the client. The SVG whiteboard image includes awareness information showing the visible screen area during creation as a rectangle.

Due to its text format with high repetition of terms, SVG can be compressed efficiently[3]. Compared to the our previous approach rendering images on the server, we have are about 10 times quicker on the server-side[4].

The loudness analysis data is generated after completion of the video recording on the server. The whiteboard activity bars will be computed on-the-fly. Therefore we developed minimalistic web services (PHP applications), that deliver the data in JSON format. The client-side UI framework takes care of the rendering. The UI is based on jQuery UI components, which were subclassed to enable the history browser specific visualizations, such as the activity bars. Video playback is realized via a Adobe Flash player that gets the video content streamed from the Red5 Media Server[5].

IV. Evaluation - Feedback on the History Browser Tool

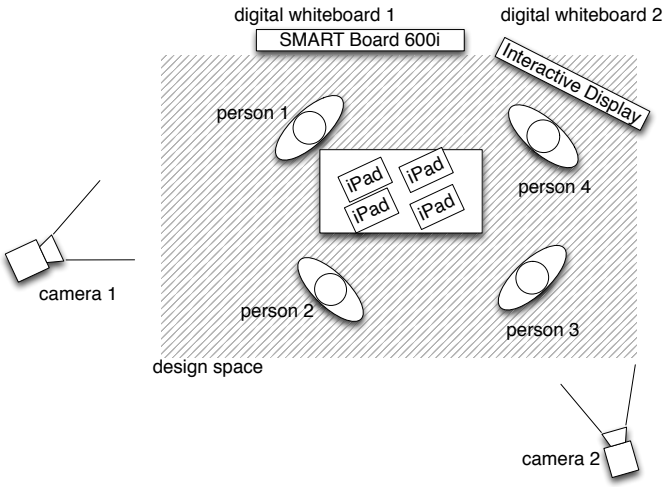

Figure 2: Camera and workspace setup: four subjects are standing in front of two digital whiteboards, using iPads as sticky note pads (at a table) while being captured by two cameras

The experiment consists of two stages. For the first stage, we had five day-long sessions including 4 participants each. The physical experiment setup is shown in Figure 2. The teams had two separate digital whiteboard devices which

[3]We use an Gzip compression built in the Apache web server. Largely depending on the content, we achieve compression rates of about 1:4-1:6.

[4]The SVG creation on the server takes on average (mean over the requests of about a month) 146ms, while having a minimum request time of 5.4ms and a maximum execution time of 429ms. The traditional approach is largely dependent on the file size (resulting from the content complexity and image dimensions) and took multiple seconds to complete.

[5]http://www.red5.org/

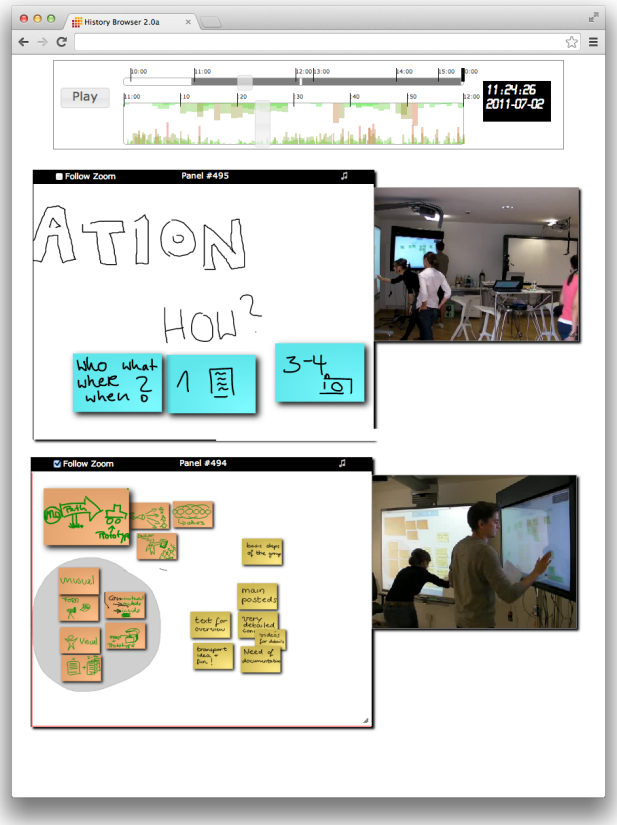

Figure 3: Screenshot of the History Browser Application showing a session with two simultaneously used digital whiteboards with an integrated two-angle video conference

were to be used with the Tele-Board whiteboard software. Each session was captured by two video cameras including audio. The position of the cameras was adjusted in order to capture as much as possible from the design space area. Camera 1 captured a distance shot, while camera 2 was placed closer to the people's interaction on the boards. Every camera focusses on one whiteboard, so that it is possible to assign one video-stream to one whiteboard. The task of these five teams was to run through a complete design thinking process [24] coming from understanding the problem domain, synthesizing their insights, ideating on possible solutions and coming up with a prototype. The challenge was called "enhancing the documentation experience for all different parties involved at the d.school"[6]. Although the different teams in the historic sessions ran through the different process steps, the results differed significantly. There were more structured teams having sophisticated forms of schematization and a straight-forward approach, but there were also rather unstructured forms of team dynamics with a more iterative approach, where people were reworking things a lot more often.

[6]See [24]. d.school is the School of Design Thinking at University of Potsdam, Germany or the Institute of Design at Stanford University

We captured altogether more than 50 hours of video alongside the whiteboard data which is automatically stored in the Tele-Board history database. These experiments took part in 2011 involving 20 participants.

For the second stage, which is the actual testing of the history browser, the task was to understand what has happened in the past sessions. These tests where taken out with individuals only. They had a rather loosely defined time frame (about 30 minutes) in which they should (verbally) answer as much comprehension questions as possible. The overall goal was to understand how people approach the problem of understanding an past session as quickly as possible. Apart from that we wanted to know, how would they use a tool that gives them the possibility to play around with historic sessions. They used our fully functional prototype (see Figure 3) to achieve certain tasks.

A. Study design, probands' tasks

The list of questions given to the participants of the study consisted of a general part and a sessions-specific part. There were questions such as "What was the challenge?" or "What technique did they chose for their POV? [point-of-view]". As an initial start to the history browser test session, the participants where introduced to their situation: "Imagine you are working within a design thinking team, but you were ill for one day. Your team had a one-day challenge and you want to build up on their ideas and understand what has happened.". There was no additional information given to neither the task, nor the team that worked on the challenge. After that we had a two-minute introduction of the history browser tool. The participants were shown how to work with the user interface and which component has which meaning. This introduction was the same for every participant and - surprisingly - no one challenged the task nor asked questions to the user interface, allowing us to assume a certain degree of intuitivity of the UI. Each of the six participants was only presented with one design session to limit learning effects.

B. Participant feedback

A major finding of this user study was the high influence of the participants' previous process acquaintance. During the design thinking process, there is a number of activities that is hard to distinguish for an outside observer. People being acquainted with the typical nature of activities (synthesizing information, building a persona, brainstorming etc.) and their typical order, can dive into content-related questions much quicker rather than wandering around aimlessly and trying to find out about the process steps first, before dealing with content-related questions.

The way of how people work with the tool is less related to their process knowledge. There are participants jumping wildly through the timeline, but others steadily moving from the start to the end and just skipping over parts of less interest. It seams to be more dependent on their personal way of dealing with a list of task items (the questions). An interesting thing is that people watched the early phases of the process (before the lunch break) more intensively than the second half. A possible explanation for this behavior could be: People were not as familiar with the overall setting in the first part as they have been in the second. Asking a participant about this particular behavior after the test, he replied:

> "[...] I think in the first part I didn't know too well about the team's tempo. While using the system a little bit, I could better estimate how much information I would miss, when skipping over a certain amount of slider length and be a bit braver. (*translated*)"

Within the history browser interface there are different media types being shown at the same time. From the feedback we found out about the importance and helpfulness of the different measures. A participant said regarding the video playback functionality:

> "I cannot directly discern something from the video, but without, it would be difficult to follow the voices. I do not interact consciously with the video, but it helps to easier follow the dialogues. (*translated*)"

This corresponds to statements of other participants, e.g. one ranked the importance of the different sources according to their perceived value: (1) whiteboard - to give a rough understanding of the content; (2) audio - to understand discussions and decisions made; (3) video - involvement of team members and the general dynamics of the team. Other participants ranked similarily, some switched the order of 2 and 3.

The activity figures (loudness, whiteboard activity) as annotations in the detail slider were more difficult to rank. Participants perceived those indicators as generally helpful to find important states in the process. Concerning the questions about the team's "how might we"-question, one participant used this data really clever to deduce and find the next important point in time. When he found the first question, he correctly noticed:

> "Well, there is no activity on the whiteboard after now, but the loudness goes up. Ok, they are discussing about the question, then they decide something, activity goes up. Yes, there must be the final question over here. (*translated*)"

We expected feedback on the overview slider's non-linearity. Participants just noticed it and remarked (when asked) that it is often not so important to see absolute periods of time. In the detail slider they can "measure the correct numbers, but no one will ever want to find out about the length of the lunch break or so" (*translated*).

Participants asked for a way to annotate on the overview slider. They could image they would have liked to add bookmarks to the timeline, to mark states were they want to go back to. There was also the proposal to let the original team add annotations telling about the phases they were working in. This could ease the interaction with the history browser. When asked if they would do it, when being focussed on a creative session or afterwards, they replied "I don't know".

People also wished for a possibility to play faster than the original speed together with a button for skipping backward and forward over an interval of one to five minutes. One of the participants forgot during scrolling, if he went forward or backward in the timeline. They also wished for a possibility to select content (e.g. a sticky note) and see its creation time as a marker in the timeline.

C. Understanding achievements

Overall, the participants did a good job in answering the understanding questions. All of the participants could find an answer to most questions. We did not limit the time strictly, so some participants needed about 40 minutes to answer the questions sufficiently, some needed significantly less time (about 15 minutes). It turned out that the understanding success is to a large extent influenced by two factors: the personal acquaintance with the design thinking process and the scope of the questions.

First factor might not be as relevant in real-world settings, as people are used to the overall session setup of meetings they have been absent from. Nevertheless, the result from less acquaintance with the working process expresses itself in longer browsing activity. It does not necessarily worsen the results. Thus, people being more comfortable with the process were less likely to ask for annotations on the timeline.

Second, questions with a broader scope are more difficult to answer than very specific questions. We assume that this observation is not specific to the tested problem domain. For instance the question ”What technique did they chose for their POV?“ could be answered much faster than ”Why did they choose their persona?“. The nature of the second question makes it necessary to view much larger sections of the timeline. Apart from the time factor, it was perceived easier to answer questions with a clearly articulated answer in the recording than an answer derived from the discussions.

D. Usage log analysis

From the server logs, we extracted the frequency of requests of different whiteboard states (i.e. timestamps that were requested). A visualization of this data is shown in Figure 4.

Special attention should be drawn to markers A and B in Figure 4. A shows substantially higher activity of history browser viewing activity compared to the amount of whiteboard events available in the timespan. Correlation between whiteboard activity and history browser activity is hardly identifiable. At timespan B it is a bit different. One can see that moments when a lot of activity has taken place on the whiteboards, the more intensely people look at the history. Overall, a correlation of whiteboard activity and history browser review activity is not provable.

It is interesting to see that the usage pattern aligns with: (1) the availability of video (2) the intensity of the discussion in the first part of the process. Number 1 appears to be less important, as there was video captured at times when people were working in front of the cameras. In real-world settings the overlaps might be a little more interesting.

Number 2 is more interesting, as there is no easy explanation for this behavior. One possible answer is just the higher intensity of the discussion in the first part of the day, as people were really arguing about how they perceive the problem etc. A second answer is the usage behavior of the history browser. When people started using the system they were rather shy and were not so confident in skipping through the whole session. So a majority of the study participants looked at the data more closely in the first part, because they maybe had the fear of loosing important information. Those participants, who were not acquainted with the process of design thinking, were also searching for the how might we questions in the first part (observation and definition phase).

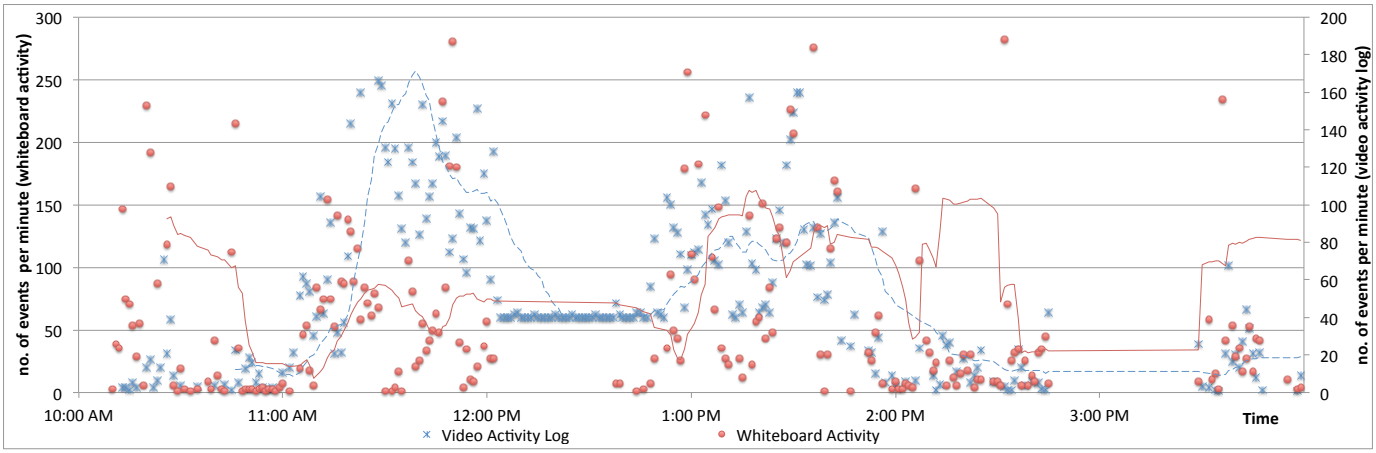

Figure 4: Usage data showing the frequency of whiteboard states being requested by the history browser application: x-axis shows the time of the whiteboard state, right y-axis (blue cross) the number of history browse requests on a particular timestamp, left y-axis (red circle) the number of whiteboard events at that timestamp. Lines indicate a moving average of 20 minutes.

One might have the idea that it could make sense to use the usage data for a feedback cycle and display the usage peaks also within the history browser interface to enable people finding states of work which were important also for other people. We are not in favor of doing so, because in the typical usage environment there will only be very few people looking at a session afterwards, so the non-existence of usage peak markers could lead to the understanding that there was just no important content. Those people pioneering on browsing a specific session will have the same difficulties as before.

V. Conclusion and Outlook

From this very first study, we found out that it is definitely possible to achieve an understanding of past sessions by providing people with a tool to explore content together with additional information, such as a video/audio stream and information telling more about the nature of the interaction (e.g. loudness information or an activity indicator). Study participants did a very good job in achieving the given tasks. Compared to traditional design work documentation items such as wikis etc., the history browser can give more objective perspectives on past sessions.

There are more sensors imaginable to be integrated into the system. We work on a solution capturing more person-focussed data within the system. This can be skin-conductance, heart-rate, and temperature. Therefore, we plan to equip participants with wristbands that capture this information in order to have this information display close to the historic data and allow people to easier find moments of special intensity.

Currently, analysis of the additional data (e.g. loudness) is not entirely automated. Video capturing is done automatically, but the additional analysis of e.g. the loudness information must be triggered manually. This will be integrated, to be able to watch sessions directly after they took place.

Altogether, we found out that this kind of self-documenting collaboration equipment can be a step towards a more successful asynchronous interaction of co-located as well as distributed creative teams.

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