Physically Embodied Video Snippets Supporting Collaborative Exploration of Video Material During Design Sessions

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ABSTRACT
In this paper we explore the idea of using physically embodied video snippets as an alternative to today’s means for control of video playback during collaborative design oriented meetings. We aim to make video snippets a more integral part of the shared resources and opportunities for action already present at brainstorm like meetings. We present our VideoTable and VideoCards. The VideoTable is an augmented meeting table. The VideoCards are paper card representations of video snippets embedding means for control of video playback. Our implementation is based on modified passive Radio Frequency Identification (RFID) tags. Preliminary observations of use indicate that our VideoTable and VideoCards enable the seamless mix of video snippets with other physical design artifacts we are aiming for.

Keywords
Augmented reality, Tangible user interfaces, paper interfaces, RFID tag technology, multimedia interfaces

INTRODUCTION
Watching video is nowadays a fairly common part of the activities taking place during design-oriented workgroup meetings. The videos shown are rarely full-blown professionally edited presentations but most often rather raw and relatively short video snippets. The video snippets are introduced as a way to inspire and stimulate discussion amongst members of the workgroup. This suggests an interactive mode of video viewing where basic control of video playback should be as easy and as accessible to all meeting participants as any other shared resource present to support the group discussion. But looking at today’s means for video playback they are predominantly designed towards a presentation style more similar to what you would expect to find in a home movie theater setting. In a typical meeting room setting (Figure 1) the work group participants are seated around a table and playback of video is controlled either by means of a remote control or through point and click operations in a graphical user interface (GUI) on the meeting room computer.

Figure 1. Traditional setup and means for control of video playback.

Whether a remote control or a GUI is used they both enforce a mode of interaction that makes it difficult to integrate playback of video with other collaborative activities part of the meeting. In particular they both require a shift of attention from subject matter to device operation. Further, in this set up engagement with video snippets is only made possible as a foreground activity. That is, when a video is playing it becomes the focus of attention while, when not playing, it seems to disappear completely. The process of watching video thereby tends to monopolize the situation and introduce an abruptness disturbing the overall flow of meeting activities. Hence, watching the playback of video is often experienced as an isolated activity that takes place in its own space for interaction; a space separated from interaction with other shared resources present. Finally, today’s means for control of video playback are
designed as single-user interfaces not easily allowing a group of people to share the control.

In this paper we address the question of how to make the interaction with digital video snippets a more integral part of the overall collaborative activities during design-oriented workgroup meetings. We aim to bring digital video snippets out of isolation and make them part of the pool of shared resources and opportunities for action present at design-oriented meetings. We will in particular look at the design and implementation of a prototype that seeks to enable a more smooth transition between collaborative engagement and dis-engagement with video snippets. This implies making possible a background as well as foreground mode of engaging with the video material and a mechanism allowing the participants to move between the two. Pursuing this kind of smooth transition we suggest that a physical embodiment of video snippets embedding means for control of video playback can help alleviate the problems encountered with today’s means for video control. In particular we propose that the use of paper cards with permanently attached pushbutton controls for the playback of video snippets can enable a seamless and more constructive integration of digital video material with other shared resources present during design-oriented meetings. Our VideoTable allows a group of 4-5 people to gather around an augmented meeting table and manipulate and organize VideoCards together with other physical artifacts present on the tabletop. A VideoCard provides the participants with a tangible representation of a video snippet and very important, it enables immediate access to playback of the associated video snippet. Playback of video is initiated by pressing the pushbutton located on each VideoCard. The VideoTable detects and identifies the VideoCards through the use of modified passive Radio Frequency Identification (RFID) tags.

The next section takes a closer look at our design rationale and some of the characteristics describing the type of use situation we are designing for. We then present a scenario illustrating use of our VideoTable system followed by a section on related work. A section then presents the implementation of our VideoCards and VideoTable prototype. Preliminary observations of use are presented, followed by a section describing ongoing work and ideas for future prototyping. Finally, we summarize and conclude.

This paper gives a much more elaborate report on our work with the VideoTable than the CHI2002 interactive poster presentation of our VideoTable prototype (Sokoler, Edeholt et al. 2002).

DESIGNING FOR COLLABORATIVE EXPLORATION OF VIDEO SNIPPETS DURING DESIGN SESSIONS

While we believe that the ideas we present are applicable to many types of meetings we will in this paper focus on one particular type of use situation. A type of use situation that brings forward a particularly strong demand on the seamless integration of video playback with the interaction between group members and the group members interaction with other artifacts present. The type of use situation in question is inspired by work of colleagues in our research laboratory. We take as point of departure for our design the general idea that digital video material can be used as inspirational and expressive material during design sessions. This perspective on the use of video material has been explored in several design workshops over the last couple of years and described in the papers by Buur et al. (Buur and Soenderborg 2000),(Buur, Binder et al. 2000). It is beyond the scope of this paper to discuss the general design methodological implications and the overall appropriateness of this approach to the use of video as design material. We will take our colleagues approach for granted and focus on the implementation of a particular system seeking to make possible a fluid and collaborative engagement with video material during design sessions.

In the kind of use situations we are designing for video material is only one component to be used alongside a diverse set of other design artifacts. These other design artifacts are either produced at, or prepared in advance and brought to, the design session. Typical design artifacts include printed documents, PostIt notes, cardboard mockups, early semi-functional prototypes, etc. The design artifacts are placed on a meeting table and the participants thereby establish a shared physical space for their design activity. In this setting all participants have direct and easy access to the artifacts on the meeting table. The shared physical design space offers immediate opportunities for action with each artifact serving as a point of possible interaction. Besides personal belongings such as for example personal notes all other artifacts present on the table are considered as belonging to the pool of shared resources supporting the overall group activities. The qualities of persistence and tangibility inherent to physical artifacts seem to be crucial when shared by participants during design sessions. Physical artifacts can easily be passed around, manipulated and organized in physical space by the participants. They serve as temporary focal points for the group discussion and permanent reminders of earlier stages in the discussion. Further, the physical presence of these artifacts helps the participants hold on to important decision points; points of disagreement or points of consensus, evolving as the session moves forward. Through their persistent presence the artifacts not only makes possible a focused mode of engagement but even a more subtle background mode of ‘just being available’. In this way the artifacts allow the participants to take in at a glance the available shared resources. The artifacts thereby lend themselves towards opportunistic use and the transition between noticing that an artifact is available and actually starting to engage with that artifact. A moment-to-moment transition emerging in the meeting between participants and the continually present artifacts.

When trying to introduce video snippets in this environment, with today’s means for video control, it becomes evident that the ephemeral and intangible nature
of video playback stands in sharp contrast to the persistent and tangible qualities inherent to the physical design artifacts. The video snippets do not offer a mode of background engagement and mechanisms for subtle approach before engaging in watching the video. You are either engaged in a focused process of watching the video snippet or not interacting with the snippet at all. As a consequence the engagement with video snippets becomes separated from the collaborative activities involving manipulation and spatial organization of the artifacts present on the meeting table. Watching the playback of a video is therefore often experienced, as an isolated activity of its own not easily integrated with other design session activities.

Pursuing a higher degree of integration between video snippets and other shared resources present we specifically identify three problems with today’s interfaces for, access to, and control of video snippets:

- The ephemeral and intangible nature of video snippet representation making it difficult to hold on, and refer, to a video snippet not currently playing
- The separation between means for control and the individual video snippets preventing direct and easy access to a particular video snippet during an evolving group discussion.
- The single-user interface enforcing a centralized ‘bus driver’ mode of operation with one person in charge while the other participants are left without means for access to, and control of, video snippet playback.

Guided by the general idea of physical embodiment we try to alleviate these problems and meet the challenge of turning video snippets into a more accessible shared resource. More specifically we provide each video snippet with a physical body in terms of a paper card (VideoCard). In this way the video snippets gains properties resembling the properties held by other design artifacts present in the shared physical design space. In particular the video snippets now have a persistent presence enabling them to be an integral part of the spatial organization of design artifacts on the tabletop. We further try to strengthen the notion of embodiment by deliberately aiming for a design where no external tools such a for example bar code readers are required to control the playback of video when having a VideoCard at hand. The VideoCards themselves embed means for control of video snippet playback. In this way physical manipulation of a VideoCard enables direct control over playback of the digital video snippet. By placing the means for control in context we aim to enable a more smooth transition of discovery, engagement and dis-engagement with the video snippets. In general we try to emphasize that the VideoCards should work as more than yet another input device for control of video play back. Throughout our design we aim for a use experience where the VideoCards are looked upon as meaningful physical artifacts in their own right with the extra capability of providing easy control of video play back when called for.

As described above the brainstorm like use situations we are designing for are characterized by, and thrives on, an extreme openness relying on the amazing human capability to take in at a glance and make associations between resources on a moment-to-moment basis. We deliberately aim to introduce our VideoCards in a way that allows this kind of openness. In particular, we choose a strategy that avoids the implementation of system features that tries to foresee, infer on the basis of rules, or ‘know’ what the right way of using a VideoCard is. Rather, we deliberately leave this up to the people engaging with the VideoCards in a firm believe that humans are far superior experts in exercising these judgment calls and will do pretty well if allowed to do so.

In this way the overall design rationale behind our VideoCards is to complement and enable rather than substitute and take over the role of other resources present. Resources in this context not only including tangible objects but even our amazing human skills for sense making, communication, and collaboration.

**A VIDEOTABLE USE SCENARIO**

The following scenario describes an envisioned use of a VideoTable and VideoCards at a R&D lab design meeting. The meeting is the second in a row of meetings where opportunities for the design of personal communication devices are to be explored. In this particular meeting the group has decided to take a closer look on possible ways to better integrate functionalities already known from existing personal communication devices.

In preparing for the meeting Tom has been conducting a brief field study. He has been visiting Anne who is in charge of coordinating the work of field service engineers at a major company specializing in systems for indoor climate control. During a one-day visit Tom video taped Anne as she went about doing her daily routines. Tom has about 5 hours of video recordings. The day before the design meeting Tom goes through the video recordings. In accordance with the agenda for tomorrows design meeting he in particular looks for places where Anne makes use of devices for communication. He finds 11 characteristic situations that he believes are of interest and save these as individual 1-2 minute long video snippets. Tom then, for each of these snippets, prints a paper card with a descriptive key frame, a title and some keywords. He prints the cards using the VideoCard print template. Tom attaches a VideoCard pushbutton to each VideoCard. One at a time he then places the VideoCards with pushbuttons on his enhanced mouse pad. When pushing a VideoCard pushbutton a drag and drop enabled window shows up on his computer monitor. For each VideoCard Tom now drags the file containing the video snippet into the window and thereby associates a video snippet with a VideoCard. Would have been easier to use the special VideoCard printer that prints, attaches buttons, and associates video.
snippets with the VideoCards in one operation, but unfortunately for Tom his manager, Susan, thinks the VideoCard printer still is too expensive. After having made the 11 VideoCards Tom copies the files containing the video snippets into a public folder on his desktop computer thereby making them accessible to the meeting room computer through the company intranet. Besides the VideoCards of Anne, Tom also decides to bring along 6 VideoCards from a study he conducted last year. In last summer’s study Tom looked at how the members of his son’s soccer club coordinated the planning of a local tournament. After all, tomorrow’s meeting is not about designing for Anne in particular but rather about getting an overall first grip on the broader notion of people, communication, coordination and technology.

At the day of the meeting Tom, Susan the group manager, Ken the guy in charge of new technologies and Rose a sales representative visiting from the company’s headquarters gathers in the lab’s brainstorm room. When Tom enters the room Ken is already there scrambling through a box full of cell phones, PDAs, and brochures describing the many different kinds of communication devices available today. Ken places his gadgets and glossy pamphlets on the meeting table also serving as the VideoTable. Tom pulls out his stack of VideoCards and puts them on the table in front of him. A few minutes later Susan and Rose shows up and the meeting begins.

After a short introduction of Rose, Ken starts showing some of the existing communication devices and passes the gadgets around as he talks about their features and limitations. Tom is next. He briefly introduces the indoor climate company, Anne and his son’s soccer team. He starts by telling the story about how Anne uses a variety of means for communication like cell phone, fax, PostIt notes, e-mail, SMS etc., in her daily communication with the field engineers. While telling his story Tom activates play back of the appropriate video snippets showing Anne in her work context performing the tasks he is talking about. Whenever Tom pushes a button on a VideoCard present on the tabletop the video snippet is shown on the projection screen at the end of the table. On the fly Tom decides which video snippets associated with the VideoCards that deserves to be played in full. The video snippets not viewed are briefly introduced by holding up the VideoCards and reading out loud the printed title and keywords. Tom leaves the VideoCards already talked about on the table as he goes along. While Tom is talking Rose’s pager goes off. ‘How appropriately inappropriate’, she says with an embarrassed smile while she unclips the pager from her belt. She then reaches over and places the pager on top of the VideoCard titled: ‘Notification Mechanisms and Disturbances’.

Tom talks for about 20 minutes. Susan now suggests that they start to look at possible connections between the video snippets and Ken’s material by grouping gadgets, brochures and VideoCards on the tabletop. During this organization of material the VideoCards are moved around and the associated video snippets played as a way to support the particular groupings. The discussion becomes lively, as all four of them starts using the VideoCards along with the other materials on the table as building blocks in the construction of new scenarios describing the use of possible future personal communication devices. After two hours of intense discussions Rose thinks it time to present some sales data that she believes is relevant for the discussion. As it will take a while for Rose to boot her laptop and connect it to the meeting room projector Susan suggests that they take a 10 minute break.

Leaving the room Tom can not help but smile when he sees that a VideoCard of his 10 year old son forgetting his soccer shoes for a game last summer ends up next to a cell phone, a coffee cup, Rose’s pager and a VideoCard of Anne showing how she forgot to bring her electronic day planner to the informal Friday afternoon gathering with the field engineers.

RELATED WORK

The papers by Buur and Soendergaard (Buur and Soenderborg 2000) and by Svendsen and Soendergaard (Svendsen and Soendergaard 2000) introduces a ‘Video Card Game’ and the use of paper cards as physical representations of video snippets. A still picture from the video snippet and a title is printed on each card. We have borrowed the notion of VideoCards from their work. But our work takes the idea of using paper card representations of video snippets one step further by demonstrating how the playback of video can be made an integral part of physically manipulating the cards while distributed on the tabletop. In our design we particularly emphasize the physical embodiment of video snippets and that the means for control of playback are placed on the VideoCards themselves. Hence, in our design we deliberately seek to avoid the need for extra devices such as for example barcode readers when identifying the link between VideoCards and video snippets.

In their paper Lange et al. (Lange, Jones et al. 1998) present the Insight lab system for collaboration and organization of documentary material across the media boundaries between paper and video. In their system, much more developed than ours, a barcode reader is used to identify the link between paper notes and video material. Again while the overall strive for a more seamless interaction across different types of media during design-oriented meetings is similar to ours we deliberately try to emphasize the notion of physical embodiment by having the VideoCards themselves embed means for control.

The Mosaic system (Mackay and Pagani 1994) demonstrates how paper cards can be used as an interface for storyboard editing and how the physical cards makes possible a spatially arrangement, and direct access to manipulation, of storyboard content. Our work explores these same qualities offered by physical embodiment but emphasizes the integration of physically embodied
computational resources with a collaborative setting encompassing other design artifacts.

There are many examples of tangible human-computer interfaces demonstrating how manipulation of physical objects can be used to initiate computational processes. Related to our work on providing tangible handles to video material is the MediaBlocks system (Ullmer, Ishii et al. 1998) where wooden blocks are used as generic physical placeholders for video material. Rather than using generic placeholders we have deliberately aimed for a design where each of our VideoCards explicitly represents and is permanently associated with a specific video snippet. Our VideoCards are intended to be more than interface components for playback of video. The VideoCards are intended to be physical artifacts that can enter the design discussion along with other physical artifacts and be manipulated and organized as meaningful objects without necessarily activating the playback of video.

The work on paper interfaces and in particular the Palette (Nelson, Ichimura et al. 1999) showing how paper cards are used to control multimedia presentations and PaperButtons (Pedersen, Sokoler et al. 2000) exploring how the controls for multimedia presentations can be embedded in paper have served as direct sources of inspiration for our VideoCards. In particular, the notion of providing persistent mappings between pushbuttons located on paper cards and multimedia control functions are very much in thread with (Pedersen, Sokoler et al. 2000). But also the notion of tacit interaction and the goal of turning access to computational resources into a much less obtrusive task is strongly related to our work. The main difference between these papers and the work presented here is that we are designing for a collaborative setting and hence, introduce an augmented meeting table, with multi-user access to the multimedia content, as the arena for interaction.

Many examples have demonstrated how passive RFID tags can be used to link physical objects with computational processes as part of novel user interfaces. In systems such as for example (Want, Fishkin et al. 1999), (Rekimoto, Oba et al. 2001), (Back and Cohen 2000) passive RFID tags are embedded in physical objects and by moving these objects near a tag interrogator their digital identities are revealed and used to implicitly initiate computational processes. Our use of passive RFID tags is somewhat different. We have modified the standard RFID tag technology and added a more explicit temporal control making it possible to bring and manipulate a tagged VideoCard near a tag interrogator without immediately activating the associated computational process.

Finally, our work is in general inspired by work on augmented reality as it was presented in the early 90’s before the term augmented reality, in our opinion wrongfully, was narrowed down and made synonymous with applications that overlays computer generated graphics on physical objects.

**VIDEOCARDS AND VIDEOTABLE PROTOTYPE**

This section describes our current prototype implementation of the VideoTable and VideoCards.

The implementation of our prototype consists of two major sub-systems: The VideoCards and the VideoTable. In terms of technology our implementation revolves around a 125kHz RFID system using passive Philips Hitag1 transponder chips (RFID tags) (Philips Hitag1, 2002) and four Micro RWD H1C tag interrogators from IB Technology (IBTechnology, 2002). Being passive in this context means that the RFID tags operate without the need for individual power supplies/batteries.

**Figure 2. The VideoTable and VideoCard**

The only power needed to run the system is supplied through the tag interrogators in the VideoTable. Standard passive RFID tags are normally detected and identified as soon as they are moved into a tag interrogator’s electromagnetic field. We have modified the passive RFID tags by inserting a pushbutton in the tag circuit (see right hand side of figure 2). As a result of this modification the RFID tags can be present in the electromagnetic field produced by the tag interrogators without triggering an identification process until pressing the pushbutton closes the tag circuit. In terms of use this means that the VideoCards can be present on the VideoTable top without setting of playback of a video snippet until a design session participant explicitly chooses to initiate playback by pressing the VideoCard pushbutton.

The VideoTable is a 75x75 cm acrylic surface on top of four antenna coils connected to each their tag interrogator. We chose the transparent acrylic surface in order to make it easier to explain the inner workings of this early prototype. The left hand side of figure 2 shows a picture of the overall
system with 9 VideoCards distributed on the VideoTable surface. The only limit to the number of VideoCards that can be present on the VideoTable is the physical area of the tabletop. The cards can be moved around freely on the VideoTable without initiating the playback until activated by a design session participant. A VideoCard can be identified and video playback initiated as long as the VideoCard is within 5 cm of the VideoTable surface when the pushbutton is pressed. Other physical artifacts can be present on the VideoTable thereby allowing the participants to easily refer to and mix in VideoCards with the overall spatial organization of design material. One limitation though in terms of other materials present is that large metallic bodies can disturb the electromagnetic field produced by the tag interrogators and thereby make the identification of a VideoCard difficult.

Our VideoCards (see top right corner of figure 2) are 8x10 cm paper cards and holds the picture of a video key frame from the associated video snippet. In our current prototype the preparation/production of VideoCards is done all by hand. First a key frame is selected from each video snippet and printed onto a VideoCard. The name of the file containing the digital video snippet is then associated with a 32-bit number encoded in the pushbutton activated RFID tag. Finally the pushbutton activated RFID tag is permanently attached/glued to the card. When a VideoCard pushbutton is pressed the 32-bit tag ID is read by one of the four tag interrogators beneath the VideoTable surface and passed on to a PC via the serialport. Each tag interrogator can only detect tags within a limited area and with the current size of our VideoTable four tag interrogators are needed to cover the whole surface. Scanning of the four tag interrogators is controlled by a BasicStamp microcontroller. A VisualBasic application running on the PC receives the ID and uses a simple lookup table to map the ID to the video file associated with the VideoCard and playback of the video snippet begins using the WindowsMediaPlayer. The video playing is projected onto the screen at the end of the VideoTable. Typical response time from pressing a pushbutton to the start of video playback is about 500 msec.

Using RFID tags inside our pushbuttons as the linkage mechanism between VideoCards and digital video snippets immediately gives the system some appealing properties in terms of scalability. Each of our tags is capable of storing 2 Kbit of data in its read/write memory thereby providing a huge address space for unique tag and hence, unique VideoCard identities. This combined with the fact that the RFID tags operate without the need for batteries immediately supports the notion of VideoCard repositories. That is, VideoCards once used can be kept around and reused when appropriate over a basically indefinite period of time. This of course presuming that a likewise repository/storage mechanism is in place for the digital video snippets. Finally, RFID tags are fairly inexpensive and it is projected by many (see for example (AlienTechnology, 2002)) that ongoing improvements in RFID tag production technology will make the price drop even further in the near future.

**PRELIMINARY OBSERVATIONS OF USE**

In this section we report on actual use of our VideoTable prototype as we observed it at two workshops held by colleagues in our research laboratory. The observations presented here are not based on a user study planned in detail. The observations should therefore be regarded, not as a thorough evaluation, but rather as a first peek at whether our overall concept would gain any acceptance by the participants during design-oriented meetings. We introduced our VideoTable as a facility to one of the groups present during two one-day design workshops. We barely gave any instructions on how to use the system but simply made it available on the meeting table and let the groups start using it. In preparation for the workshops we had prepared 9 respectively 10 VideoCards. The VideoCards where prepared in collaboration with colleagues responsible for the workshop and represented video material of their choice. Also, our colleagues would introduce the general idea of using video snippets and present the content of the individual video snippets (see figure 3) as way to initiate the collaboration around the design task at hand.

![Figure 3. Introducing the video snippets at the beginning of the group session.](image)

Besides using the VideoTable to activate play back of video snippets this presentation was similar to the presentations given to the other workshop groups not having access to a VideoTable. In these other groups the participants would also use paper cards as representations of video snippets but in order to view the video snippets they had to manually map the numbers printed on the cards with the appropriate video snippet files using a graphical user interface. Other design artifacts to be used during the group session were introduced in the same manner.
After introducing the video snippets the VideoCards were left on the tabletop alongside other design artifacts. The VideoCards were available throughout the evolving group discussions.

The participants immediately acknowledged how easy it was to activate the play back of video and made comments on how the use of the VideoCards and VideoTable made navigation through GUI folders and file systems obsolete. In general the VideoCards were used as references to the stories told by the video snippets (see figure 5). As the group discussions evolved the references were often made without activating playback. This way of using the VideoCards may at first seem discouraging from a technology-centered view. But in fact this kind of use supports our general notion that the VideoCards should be more than just input devices for video play back. What we observed was that the VideoCards were used as meaningful physical artifacts in their own right with the extra capability of providing easy control of video play back when called for.

In one of the workshops the initial group discussion revolved around the making of an abstract map describing the relationship between typical office tasks. The video snippets served as small stories about office tasks and the VideoCards were spatially arranged on top of the map (see figure 4). While the VideoTable supports play back of a video snippet by pressing the button on a VideoCard wherever the VideoCard is placed on the tabletop we noticed that the participants would move the VideoCards to the center of the table when initiating play back. We looked at this as going somewhat against our idea that video snippet play back should be initiated ‘in-place’ and attributed this way of inventing a restricted spatial zone for play back to the lack of a separate introduction of the VideoTable capabilities. We still can not rule out that this lack of introduction was the cause. But looking closer at the particular use situation the center of the abstract map in

Figure 4. Arranging the VideoCards on the VideoTable surface and initiating ‘in-place’ playback of video.
fact had a particular role when mapping office tasks. All video snippets where originally introduced by placing them in the center of the table before they as a result of the group discussion would be moved outwards on the abstract map. We therefore speculate that the center of the map and hence, the center of the VideoTable implicitly became the ‘in-place’ for showing video snippets when discussing the placement of a VideoCard.

In the other workshop, without an explicitly imposed spatial layout on top of the VideoTable, the participants made use of the whole VideoTable surface for ‘in-place’ playback of video. In this workshop it took less than 10 minutes before the VideoTable was inhabited (see figure 6) not only by VideoCards but numerous other physical artifacts including: cardboard mockups, coffee cups, Lego figures and pieces of paper produced at the table.

These other artifacts were placed next to and sometimes even on top of the VideoCards to indicate specific relationships. During the presentation of the design concept developed by the group they asked the other workshop participants to gather around the VideoTable. They then started presenting their concept by manipulating the artifacts on the table and activating the playback of video ‘in-place’ when needed.

In general, we feel encouraged by our preliminary observations of use but obviously need to conduct more thorough studies. A general question that we would like to address is whether the overhead involved when preparing the VideoCards is experienced as being worthwhile and sufficiently rewarded by the ease of use experienced during the design meeting. This requires a more long-term study that goes beyond the immediate fascination of new technology. Further, a long term study would require a VideoTable system with a far more transparent process of VideoCard preparation.

**ONGOING AND FUTURE PROTOTYPING**

We are currently in the process of improving the robustness of the system and the look and feel of our VideoCards. We are aiming for a smaller and slimmer design of the pushbutton activated RFID tags providing a smoother surface and making it easier to stack the VideoCards. We are also experimenting with the size of the VideoTable and alternative geometric arrangements of the interrogator coils beneath the table surface to even further improve the reliability of the pushbutton tag identification process.

In general we are trying to reduce the overhead currently required to produce the VideoCards. Linking physical objects with computational resources in general poses an inherent problem in terms of how to ensure that the association process links the right computational resource with the right physical object. This problem becomes even more evident in systems like ours’ where the linkage mechanism relies on the use of non-printable components. The process of associating VideoCards with video snippets is done all by hand in our current prototype and basically requires an expert knowing the inner workings of the prototype in order to keep track of pushbutton tag identities and video snippet file names. The ultimate goal, as mentioned in the use scenario, is to have a VideoCard editor interfaced with the video editing system and a VideoCard printer capable of attaching the pushbuttons to the VideoCards and in that same process link the pushbutton tag identities with the video snippet file names. It is beyond our resources to design and construct a VideoCard printer; though we believe it is possible and other more skilled in fact could do so. But we aim to have a VideoCard editor with a drag&drop interface similar to the one described in the scenario up and running within long. This would not preclude errors in terms of linking, by accident, a video snippet file with the ‘wrong’ VideoCard but would at least make it possible for non-expert users to construct their own VideoCards; a fundamental...
requirement when aiming for more long-term studies of use.

Looking to the future, we would like to expand the system with one particular feature relevant for collaborative exploration of video material. We would like to see if our pushbutton activated tags could be used as a way to enhance the use of PostIt notes. We would like to expand our system to include what we for now call VideoNotes. VideoNotes are essentially blank VideoCards used to link handwritten notes to video passages during a collaborative viewing of raw video material. While our current VideoCards are prepared and brought to a meeting the VideoNotes would be constructed on the fly during the meeting. The VideoNote link between the handwritten notes and the video would be established by pressing the pushbutton at the time of note taking. On detecting a pushbutton being pressed the system would create a simple timestamp thereby making it possible to easily navigate to the point in the video relevant for the annotations. A system like this would in some ways be similar to the Audio Notebook system presented in (Stifelman, Arons et al. 2001) but with video and our particular emphasis on physical embodiment of individual notes intended to be shared between participants during a subsequent discussion. In this group discussion, similar to the familiar collaborative construction of mind maps, the participants would place their VideoNotes on an augmented whiteboard. The VideoNotes could be moved around and spatially arranged, possibly accompanied by VideoCards, according to groupings agreed upon by the participants. Whenever needed in order to support the discussion the video linked with a VideoNote could be played while leaving the VideoNote ‘in-place’ on the whiteboard. Though we have not yet started working on this kind of system, we believe that the technology used in our current prototype could be adapted without any major modifications.

SUMMARY AND CONCLUSION

Though watching video is a common part of design-oriented meetings it is often experienced, as an activity of its own not easily integrated with the collaborative nature of these meetings. We identified 3 common problems with today’s interfaces for video control standing in the way of this integration. Through our prototype design and implementation we have explored ways to alleviate these problems. In general we have aimed for a design that tries to bring the interaction with video snippets out of isolation and make them part of the pool of shared resources and opportunities for action already present at design-oriented meetings. We have with our VideoTable and VideoCards prototype in particular explored the notion of physically embodied video snippets embedding means for control of video playback as a way to meet this challenge of integration. As a contrast to today’s interfaces for control of video playback our system can in brief be characterized by the following properties:

- The persistence of the physical embodied video snippet (VideoCard) makes it easier to refer, and hold on, to a video snippet not currently playing.
- Access to, and physical manipulation of, a VideoCard gives immediate access to playback of a video snippet without the need for complex operation of a separate device.
- The VideoCards and VideoTable provide multiple spatially distributed points for interaction and thereby prevents the ‘bus driver’ model of operation while supporting a collaborative sharing of control of video playback.

In pursuing these goals we have deliberately chosen a technology that allows for direct identification of the link between physical objects and digital video snippets without the need for extra tools such as for example barcode readers. We have developed our pushbutton tags by modifying standard RFID technology.

On a more general note, we have throughout our design chosen a strategy that supports the kind of openness that characterizes the brainstorm like use situations we are designing for. We have aimed for a design that enables and complements rather than takes over the amazing human capability to take in at a glance, make associations between resources, and take advantage of opportunities for action on a moment-to-moment basis. As part of this strategy we have tried to design our VideoCards to be more than just input devices. We have aimed for a use experience where the VideoCards are looked upon as meaningful physical artifacts in their own right with the extra capability of providing easy control of video play back when needed. In this way we have tried to enable a more smooth transition of discovery, engagement and dis-engagement with the video snippets.

We have presented our preliminary observations of use and even though they do not qualify as formal user studies we believe they make our design efforts look promising. One of the more important questions that still needs to be addressed is whether the extra work of preparing VideoCards is experienced as being sufficiently rewarded by the ease of use experienced during the design meeting. A question that we believe requires a long term study where a robust and more complete version of a VideoTable and VideoCard system is made available as a permanent facility in a design oriented environment. The implementation of such a system is part of our agenda for the near future.

In conclusion, we believe that the actual use of our prototype during two workshops supports our initial notion that physical embodiment of video snippets embedding means for control enables the kind of collaborative exploration of video we were aiming for. We believe that the use at the workshops indicate that we in fact are on the right track in our attempt to make video snippets become a more integral part of the overall shared space of resources.
and opportunities for actions present during design oriented meetings. We intend to further explore the notion of physical embodiment of digital media and the coupling between physical manipulation and control of computational resources in collaborative settings.

Finally, we will, in our future design of digital technology, develop the approach of complementing and enabling rather than substituting and taking over the role of other resources present in the use context. An approach that we believe is closely related to augmented reality as it was presented originally.

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