The CARE Concept - Holding on to augmentable paper during post surgery rehabilitation

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Abstract— This paper presents our early experiences with the design of digital technology that aims to support the process of collaborative articulation taking place at patient-caregiver consultations during post surgery rehabilitation. We will suggest that augmentable paper documents (CARE paper) can be powerful resources in this process for caregiver as well as patient. The CARE paper can carry links to digital media. A prototype implementation demonstrating how to create and retrieve links between digital media and the CARE paper will be presented. The work presented was carried out and assessed along with studies at a major hand surgery clinic and with the active participation from patients and staff at this clinic.

Index Terms— Interaction design, Medical services, Multimedia communication, Augmentable paper

I. INTRODUCTION

CARE is short for Collaborative Articulation in REhabilitation.

Hand injuries are often traumatic events with a dramatic impact on people’s everyday life. While less severe injuries might heal perfectly in two months after surgery, major injuries provide cases where the hand may never be the same as before. In any event surgery only signals the beginning of a sometimes long and complex process of rehabilitation. Throughout this process patients are meeting with a variety of health care system representatives including physicians, physiotherapists, and occupational therapists. It is not uncommon for the patient to meet, and receive information from all these caregivers during one single day’s appointments at the rehabilitation clinic and patients therefore often leave the clinic with a complex set of instructions all important for her progress. Hence, apart from the pain, and the stress of realizing the effects of the injury on their everyday life patients in many cases also have to struggle to comprehend the complex information they receive on their injuries and the healing process.

In our of studies of consultations between caregiver and patient we have noticed how these face-to-face meetings involves a two way process of communication where many different types of information ranging from explicit instructions to more loosely stated narratives is exchanged between the two parties. Not only is the patient trying to grasp the sometimes complicated explanations and training programs presented by the caregiver. The caregiver is at the same time trying to learn about the individual circumstances of the patient’s injury and the specifics challenges in her everyday life. We will talk about this as a continual process of collaborative articulation through which a shared understanding of the current state of the injury and the necessary steps for successful rehabilitation are negotiated. In this process a number of communication devices and health care specific artifacts are brought into play. From the healthcare professional’s point of view, the formal patient record works as the main artifact serving as a center of gravity throughout the process [1]. However, the patient has no similar explicit artifact to make use of. Printed leaflets, conversations with caregivers and brief encounters with medical artefacts such as x-rays and log sheets all form bits and pieces of a growing jigsaw puzzle constituting the patients image of the situation. Information in digital form such as online resources is part of this image and it is believed that the use of digital video and still images can further strengthen understanding and communication. As a precursor to our work at the clinic, Björgvinsson and Hillgren, have showed the value of giving patients personal videos of instructions for exercises recorded during actual consultation [2]. In preliminary experiments we have reversed the process to explore how digital media produced by patients outside of the clinic might enhance staff’s understanding of the patient’s situation.

In relation to how patients move between different situations a need for representations of rehab related material arise that can be explored in a variety of ways. The way she relates to her rehabilitation differs much depending on the situation at hand. Talking to staff at the clinic, talking to employers, talking to family or trying to grasp the situation on her own are
situations with each their focus and specific ways to deal with the rehab material. This seems to call for a persistent yet flexible way of holding on to and accessing digital material pertaining to ones individual process of rehabilitation. In the following sections we will present our early experiences with the design of digital technology that aims to support the process of collaborative articulation. In particular, we will suggest that augmentable paper documents (CARE paper) can be powerful resources in this process for caregiver as well as patient. The concept was developed in conjunction with studies at a major hand surgery clinic and with the active participation from patients and staff at this clinic.

II. CARE PAPER

A CARE paper is a physical piece of paper that allows the patient and caregiver to place and hold on to regular handwritten or typed notes alongside links to multimedia snippets and web sites. In this way, a CARE paper provides a physical space for collaboration where a mix of digital and physical media can be used for the articulations used in the patient-caregiver understanding of the current state of the rehabilitation process. By integrating the use of paper documents with the use of digital media the CARE paper seeks to combine the dynamic and flexible nature of digital media with the qualities of persistence and tangibility inherent to paper. As it will be discussed in a later section a functioning prototype, demonstrating actual interaction with CARE paper, is based on Anoto technology as the technology enabling links between paper and digital content.

Depending on the issue at hand articulations on the CARE paper may vary from simple typed or handwritten notes to rich articulations combining notes, pictures, and drawings with multimedia material including links to internet based content. As shown in Figure 1 typical examples of digital media linked to a CARE paper are video instructions on training programs, internet resources on hand anatomy and how to take care of healing wounds, pointers to information on health insurance, or patient narratives created outside the clinic to help the caregiver better understand the patients background and everyday surroundings.

In general our CARE paper adheres to a design strategy that seeks to see digital technology and paper as supplementary rather than competing resources. It is, of course, necessary to be hooked up to a computer in order to make use of the CARE paper multimedia links. A CARE paper is however a powerful resource in its own right, offering opportunities for meaningful human action even without the presence of digital technology. All the familiar patterns known from the use of ordinary paper holds for a CARE paper. Hence, you may place your CARE on the fridge or as part of a pile of other documents, you may read it while on the move, and you may jot down notes and scribble whenever you feel like with the pen of your preference.

Finally, a CARE paper may take on and combine many different roles during its lifecycle. The CARE paper may serve as an agenda for an upcoming meeting, notes from a previous meeting, a to do lists, a reminder of appointments etc.

While the use of a CARE paper may differ greatly depending on the specifics of the rehabilitation process the following three scenarios will briefly illustrate some typical use situations envisioned when motivating the design of the CARE paper.

On the bus, going to a meeting with the physiotherapist, the patient has scribbled down a note about how his hand often is swollen when he wakes up in the morning. At the consultation therapist and patient start discussing this problem and the therapist suggest a specific set of physical exercises that may help decrease the swelling. As the therapists gives instruction on these new exercises they decide to make a video recording of his demonstration. After the recording ends a link to the digital video is placed on the CARE paper.
In the afternoon when the patient is about to perform his exercises at home he sits on the couch in the living room reading the written instructions. He soon realizes that the instructions are a little complicated to follow and decides to watch the video recorded earlier that day at the consultation with the physiotherapist. Using a link on the CARE paper he starts watching the recorded video on the TV.

Later that night as his wife returns from work he shows her the CARE paper and starts explaining what the doctor has said about the injury and steps for recovery. They then start talking about the problem he is having operating the car's gear lever. A while they decide that an effective way to explain this problem at the upcoming consultation may be to record him going through the actual motions on a short video. After the recording ends she writes down ‘gearshifting!!!’ on the CARE paper and places a link to the digital video just recorded.

In these scenarios we have left out how links are actually made on the paper. This will be addressed in the following section presenting an example implementation of a device for the creation and retrieval of CARE paper links.

### III. CREATING AND RETRIEVING LINKS WITH MOUSE++

We have designed and implemented a functional prototype – the Mouse++ - in order to demonstrate a feasible technology path and most important in order to explore and help us define what actual interaction with a CARE paper could/should be like. Mouse++ enables you to discover links on the paper, retrieve media attached to these links and create new links, but also serves as an ordinary mouse for GUI-style interaction with a desktop computer. In this phase of the project we have paid little attention to the special ergonomic requirement that an actual device for hand surgery patients would have to meet. Rather, we have focused on bringing forward the functionality required and in particular bring forward an effective way of moving between interaction with the CARE paper and interaction with the linked-to multimedia content presented on a display.

The Mouse++ has two overall modes of operation:

a) Screen mode. This is the default mode of operation. Mouse++ works as a regular mouse.

b) Paper mode. When in paper mode you can search for and make use of links already present on the CARE paper or create new links between points on the paper and digital content on the computer. In the current implementation, links are associated with windows XP file folders. Hence, a link constitutes a connection between a position within a CARE paper and a file folder capable of containing any type of files allowed by the operating system.

You move from screen mode to paper mode pressing one (or both) of the XBtns on the side of Mouse++. Mouse++ stays in paper mode as long as the XBtns are pressed.

**Using existing links.**

As Mouse++ is moved across a CARE paper the system keeps checking to see if the Mouse++ position is recorded as part of an existing link. If a link is detected a sound notification is given. If, at this point, the XBtns are released the content of the file folder referred to by the link is displayed on the screen.

**Creating new links**

Mouse++ allows you to create links to file folders from any point on the paper documents used. You create a link by moving Mouse++ to the position on the paper where the link should be placed and do a right mouse click followed be releasing the XBtns. The system now creates an empty file folder and displays this on the screen. Remembering that releasing the XBtns takes mouse++ into screen mode you can now immediately start adding content to the file folder by using standard GUI operations such as Drag&Drop.
Implementation

The Mouse++ prototype is implemented using a Windows XP desktop computer, a 5-button wireless mouse, and an Anoto based Nokia Digital Pen. As Mouse++ is moved across a CARE paper, it generates a stream of absolute XY-coordinates. Each pair of coordinates is shipped to the PC via a set of Bluetooth transceivers emulating an rs232 serial port connection. The Mouse++ software itself is not visible to the user but acts as a transparent layer simply mapping Mouse++ events to the windows XP explorer. Taking over mouse event handling, when in paper mode, is implemented with the use of a system wide software hook that taps into the operating systems chain of low-level mouse event handlers. The core of the Mouse++ software is implemented as a state machine with transitions triggered by two separate sources of events: a) Standard mouse events generated from the use of the mouse buttons and b) Events generated by the detection of links and Mouse++ movements across the paper. Deciding whether the current Mouse++ position is within a link’s HotZone is accomplished by the means of lookup operations in a simple hashtable over existing links. The X,Y coordinate pairs are used as the hashtable keys. The HotZone is implemented as a moving bounding box set up at each new position as Mouse++ moves across the paper. The Response time: Time between moving Mouse++ to a point on the paper and check whether this point is a link is predominantly defined by the time needed for the pen to process images of the Anoto pattern and amounts to about 350 ms.

IV. CONCLUDING REMARKS

We have presented our CARE paper and the Mouse++ prototype aiming to support the process of collaborative articulation that takes place as a pivotal part of post surgery rehabilitation. By suggesting augmentable paper documents as central resources in the rehabilitation process it may seem that we are going upstream against the dominant trend of replacing paper with digital archives and documents - a trend most clearly seen in the enthusiasm for electronic patient records (e.g. [4]). Taking offset in the experience from office automation and the apparent failure to reach the evasive goal of ‘the paperless office’ we would argue that we in general need to be more humble and careful in our drive towards digitalization of the healthcare sector. In fact, we would argue along with Sellen and Harper for a general strategy of co-existence between paper and digital resources [5]. Hence, as is the case with our CARE paper, physical documents and digital technology should be seen as complementary rather than competing resources in support of human activities. Thus, instead of seeing one as a replacement for the other we should leave room for, and seek to take advantage of, the virtues of both. With the CARE paper and with electronically augmented paper in general we seek to enhance and enrich our use of paper documents as well as our use of digital media in the meeting between the two (e.g. [6]-[8]). We prefer to use the term ‘Augmentable’ rather than ‘Augmented’ paper documents when describing the key properties of our CARE paper. This is to emphasize that we aim for a dynamic user controlled, and continually ongoing process of augmentation rather than a static pre-augmented configuration produced at the time of design. We believe this corresponds directly with the notion of collaborative articulation as a process guided by the particularities of the situation - a process that will bring the CARE paper into use in ways that are beyond the control and anticipation of us as designers.

In general, while digital technology has obvious advantages as compared to paper documents when archiving, searching, and seeking dynamic access to information, paper on the other hand seems to offer qualities that are hard to outcompete when it comes to the way it enables direct access and manipulation of information. The sheer fact that a physical document is present and can be manipulated as part of the physical environment leave it open to a variety of context specific use. Furthermore, we have found in our collaboration with patients and staff that the simple notion of actually carrying away, by hand, a physical artifact when leaving a consultation, even if this is only a simple handwritten agenda, may provide a sense of accomplishment that is hard to replace by digital means.

Being a demonstrator of functionality rather than an ergonomically correctly designed device we have not been able to conduct any real user evaluation of the Mouse++ prototype. We have however, during a series of lab style enactments and demonstrations and important during our active collaboration with staff and patients at the hand surgery clinic received very positive reactions that encourage us to believe that we are on the right path.

Finally, based on our work with staff and patients we believe that taking a consensus oriented perspective, such as collaborative articulation, on the caregiver-patient relationship looks promising in general. We are currently engaged in a number of healthcare based projects where the perspective of collaborative articulation is explored as the point of departure for design.

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REFERENCES