

MyReDiary: Co-Designing for Collaborative Articulation in Physical Rehabilitation

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Abstract. In this paper we present our exploration of co-designing for supporting a collaborative articulation of rehabilitation process. Based on our reading of key CSCW literature, we describe three facets of a collaboratively articulated rehab process: Interdependence, Distributed Process, and Interoperability. We highlight Magic-Mirror-Spiral, the design ideal guiding the co-designing of MyReDiary that is aimed to support the three facets as an example in this regard. We offer the conceptual understanding of Collaborative Articulation, the Magic-Mirror-Spiral and MyReDiary as a '*compositional whole*': an example manifestation providing an enhanced conceptual understanding that is built around our experiences of designing for collaborative articulation in specific design situations.

Introduction

Most of the developed world is facing a demographic challenge, of providing better welfare for an increasing population of senior citizens. A white paper from the Danish Government (2004) states how a successful rehabilitation of senior citizens is central in facing this demographic challenge. It defines a successful rehabilitation as follows:

"A goal-oriented, cooperative process involving a member of the public, his/her relatives, and professionals over a certain period of time. The aim of this process is to ensure that the person in question, who has, or is at risk of having, seriously diminished physical, mental and social

functions, can achieve independence and a meaningful life. Rehabilitation takes account of the person's situation as a whole and the decisions he or she must make, and comprises coordinated, coherent, and knowledge-based measures."

Simultaneously in the recent years, the field of physiotherapy is increasingly calling the attention of the therapists for a more holistic view on the nature of human body and its relation to the world. For instance, Nicholls & Gibson (2010) (for e.g.) stress that successful physiotherapy requires the therapists to develop a more holistic view that includes the everyday situation of the citizen undergoing rehabilitation. Furthermore the practice and theory of physiotherapy is increasingly realizing the importance of actively engaging the citizens in their rehabilitation process (Whitepaper, 2004), collaboratively articulating the rehabilitation process with their therapists and other caregivers (for e.g., McClain, 2005).

We read these initiatives as a broad call for promoting a 'continuous and coherent' rehabilitation process as experienced by the physiotherapists and the senior citizens. In our recent work (Bagalkot et al, 2010) we argued that there are four aspects central in answering this call: self-monitoring for the senior citizens while exercising, a more collaborative articulation of the rehab process, an integration of rehabilitation with other everyday activities, and an inclusion of friends and family in the rehabilitation process. Following up, in this paper we discuss our early experiences in designing digital technology for collaborative articulation of senior citizens' rehabilitation process post a hip replacement surgery. In particular, we highlight our co-design process that shaped the *compositional whole*, consisting of collaborative articulation as the concept, Magic-Mirror-Spiral as the design ideal, and MyReDiary as the designed artifact, together pointing to specific possibilities of designing for senior citizens to collaboratively articulate the rehab process with their therapists.

Firstly, informed by some foundational perspectives within Computer Supported Cooperative Work (CSCW), we summarize three facets of a collaborative articulated rehabilitation process: Interdependence, Distributed Process, and Interoperability. To guide our design for supporting the three facets of collaborative articulation, we present the 'Magic-Mirror-Spiral', a design ideal that guides our co-design exploration. We then present the designed artifact, 'MyReDiary': a personal device for the senior citizens that is aimed to act as a tool for collaboration by supporting the three facets. Further we describe in detail our early exploration of the design space offered by the Magic-Mirror-Spiral in collaboration with the therapists and senior citizens that lead to the formulation of MyReDiary. We then reflect on the co-design exploration highlighting how MyReDiary supports the three facets, thereby facilitating the collaborative articulation of the rehabilitation process.

Concept: Collaborative Articulation of the rehabilitation process

Physical rehabilitation can be seen as a process of constant negotiation between the senior citizens undergoing the therapy, their therapists, and other caregivers. While recent works in designing digital technology for rehabilitation (Sokoler et al, 2006; 2007; Björgvinsson & Hillgren, 2004; Hillgren & Linde, 2006, for e.g.) have addressed the need to support the collaborative articulation of rehabilitation process, yet there is need for a detailed discourse to be developed; as is developed in supporting the collaborative processes of other healthcare settings (Pratt et al, 2004; Andersen et al, 2010; for e.g.). We move towards setting up such a discourse by articulating Collaborative Articulation as a conceptual construct informed by CSCW literature, and which will further inform the design of digital technology for successful rehabilitation.

To being with, we look towards the field of CSCW that has an already established way of approaching the support of articulation work in the setting of cooperative and collaborative work. Schmidt & Bannon (1992) argue that the central focus of CSCW initiatives should be to support the articulation work that is distributed, with different actors depending on each other to make sense and achieve the work. Further Simone et al (1999) stress interoperability of the shared objects as central in collaboratively articulating work. Based on these readings and our understanding of current practices in rehabilitation, we highlight three facets of a collaboratively articulated rehabilitation process:

- Interdependence
- Distributed Nature of the Rehabilitation Process
- Interoperability

Interdependence

The success of a rehabilitation process requires the perspective that it is a collaborative effort between experts of different kinds: the physiotherapists as the experts on the bio-mechanical processes of human body, and the senior citizens as experts of their own everyday life situations, for instance. The physiotherapists have to consider each individual's holistic situation for suggesting an exercise program. The senior citizens contribute to this process by expressing their aspirations of achieving everyday activities, thereby providing a richer picture of their situation.

Distributed Nature of the Rehabilitation Process

The rehabilitation process starts at the rehab clinic with the therapists meeting the senior citizens and suggesting an exercise program based on the situation. They further suggest the senior citizens to exercise at home in between the periodic visits to the clinic. During these periodic visits, the therapists measure if there has

been any progress based on how the citizens perform the exercises. Hence the rehabilitation process moves from the rehab clinic to homes and back, with the therapists and senior citizens part of it in different times and locations.

Interoperability

Further the therapists and the senior citizens have to arrive at a common framework to make sense of the rehabilitation process. The therapists have to articulate their suggestions in the everyday language of the senior citizens and in turn, the senior citizens have to make efforts to understand the technical terms of physiotherapy. As they move ahead in this process, ideally they reach to a common understanding of each other's actions and articulations, thereby leading to a more successful process.

These three facets form our understanding of 'Collaborative Articulation' of the rehabilitation process. This understanding gives us the conceptual foundation informing our exploration of, if, and how, digital technology can be designed to support collaborative articulation, paving way for a more successful rehabilitation process.

The Design Ideal: The Magic-Mirror-Spiral

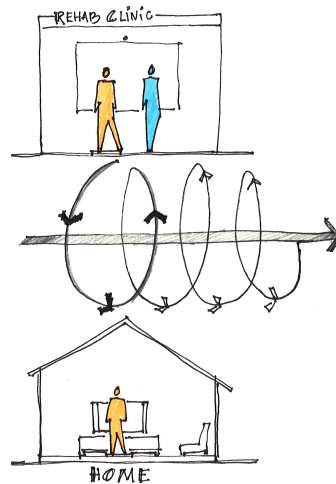


Figure 1: The Magic-Mirror-Spiral: new rehabilitation process that moves back and forth between Rehab clinic and home

The particular situation of our exploration was the physical rehabilitation of senior citizens after a hip-replacement surgery. Currently the senior citizens after the surgery undergo a six-week therapy, during which, the senior citizens visit the clinic twice a week to perform the exercises under the supervision of the therapists. Additionally, the senior citizens are recommended to exercise at home. However the therapists don't have much information on how the senior citizens

managed to do these exercises, and the senior citizens don't have much clearer instructions during exercising at home.

This situation of isolated exercise practices led us to explore the possibilities that are opened up by movement of the exercise data from the rehab center to home, and back. When the Collaborative Articulation concept met the above particular situations we formulated the *design ideal*: Magic-Mirror-Spiral¹. Magic-Mirror-Spiral drives the design exploration with its perspective of changing the current rehabilitation processes to preferred ones, allowing for more successful collaborative articulation between the therapists and the senior citizens.

The spiral starts off at the rehab center, by video recording the exercises the senior citizen performs under the supervision of their therapist. The senior citizen takes home this video and uses it as the 'reference' exercise to monitor self while exercising at home. During this the system tracks the body movements, and overlays it on the instructional video, thus giving the senior citizen a self-referential video for exercising. The senior citizen takes back this home video to the center to discuss the progress in detail with the therapist (see figure 1).

As a Design Ideal, the Magic-Mirror-Spiral points to desirable future situations that we foresee the present situation could advance to. Specifically, we foresee how by engaging in the Magic-Mirror-Spiral may support the interdependent, distributed and interoperable facets, thereby enabling the senior citizens and the therapists to collaboratively articulate their rehab process. The recording, self-monitoring, and sharing of the exercise data between the center and the home is central in supporting the three facets. Below we present our designed artifact: MyReDiary that is guided by, and exemplifies, the possibilities opened up by the Magic-Mirror-Spiral.

Designed Artifact: MyReDiary

MyReDiary is a personal device of the senior citizens that is designed for supporting the three facets of a collaboratively articulated rehabilitation process. We envision it, as a tool for collaboration, and a personal device moving back-and-forth the rehab clinic and the home (see figure 2), in addition to a self-reflection tool.

It consists of a touch pad with a webcam and Internet connectivity. The first session of the senior citizens with the therapists is recorded in the device. This becomes the reference exercise for the senior citizen at home. They can plug the device to their television and exercise, which is again recorded as video snippets. Further, the senior citizens can make notes in the form of audio and pictures, thereby preparing for their next meeting with the therapists. A set of body sensors

¹ For more information on the relation between concept, design ideal and designed artifact, please refer to Bagalkot et al (2011).

measure the muscle activities while the senior citizens are exercising at home. This sensor data is presented along with the related exercise videos, and is aimed towards the therapists who need to look at quantitative data.

In summary,

- It is a personal device of the senior citizen containing her rehabilitation data, thereby invoking a *sense of ownership* of rehab data and the process.
- It provides facilities for video recording and audio-note-making thereby giving an opportunity for the citizen to display and share her everyday exercise practice with her therapist, *providing a language* for the senior citizens to do so.
- It provides corresponding quantitative sensor data meeting the language of the therapists.
- And when the therapist and the patient meet, they can enter this data through *different 'handles'*: the sensor data, the videos or the notes

With these features, MyReDiary supports the interdependent, distributed and interoperable facets of the collaboratively articulated rehab process. We envision that as the senior citizens and the therapists move ahead in the Magic-Mirror-Spiral, some citizens may learn how to relate the quantitative data with the videos of their exercises, and the therapists may engage with the videos.

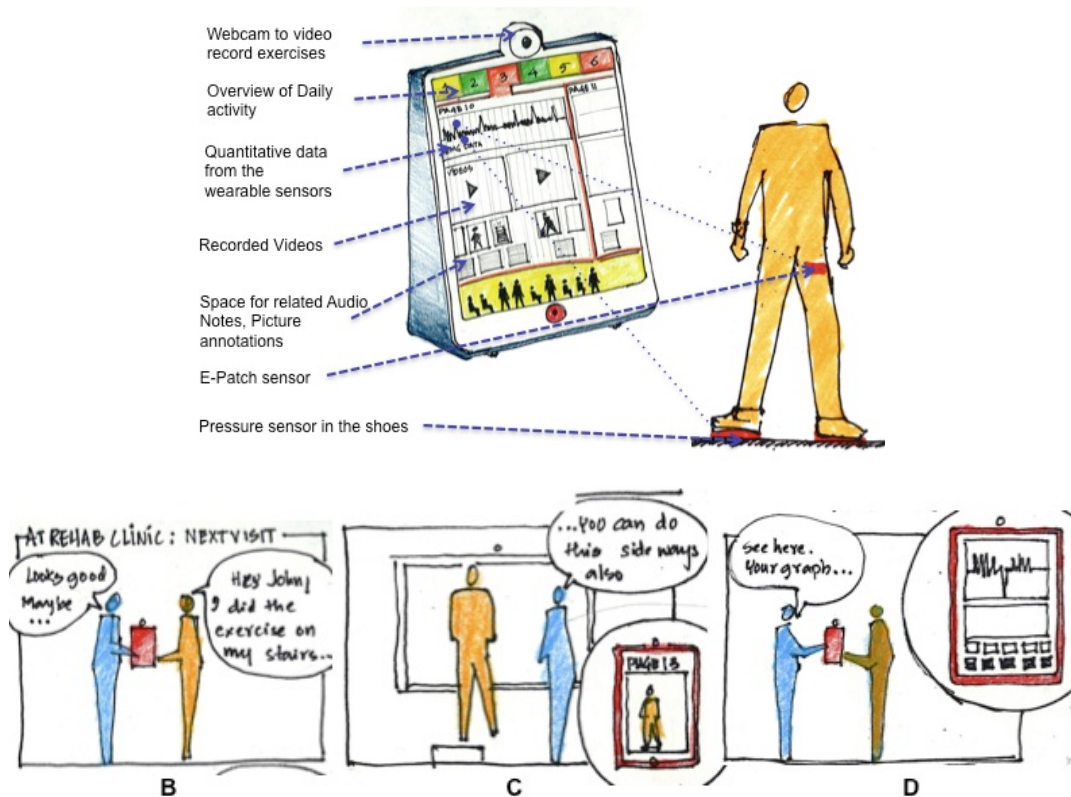


Figure 2 A,B,C,D: MyReDiary

Co-exploring the Magic-Mirror-Spiral

Our exploration of the Magic-Mirror-Spiral follows the research-through-design methodology (Stolterman & Wiberg, 2010; Zimmerman et al, 2007, Bagalkot et al, 2011), a process that is driven forward by engaging in an interplay between the conceptual construct and designing for a particular situation leading to the creation of designed artifact. As central to this process, we used early design sketches as evocative artifacts to evoke participation of the therapists and some senior citizens in the explorations, which unfolded in the local rehab center, and the living rooms of the senior citizens.



Figure 3: Sketching and Co-exploring Magic-Mirror-Spiral, at rehab clinic, home and back.

From our initial discussion with the therapists, we concluded that the vertical body position, balance of weight on feet, and knowledge about hip muscle activity are the three ‘key’ things the therapists want to monitor during the exercise process. We sketched some basic sketches (figure 3A) of a ‘balance board’ with pressure sensors measuring the weight balance, a belt with an accelerometer for vertical position, a counter for counting the number of exercises, all connected to a laptop with a webcam which video recorded the exercises, and displayed the sensor information over the video in real time. This immediate feedback enables the senior citizens to monitor their exercise while they are exercising.

The First cycle of the Magic-Mirror-Spiral

We explored the enactment of first cycle as indicated by the Magic-Mirror-Spiral: recording at rehab clinic, exercising at home, and discussing the home exercises at the rehab clinic back again.

Recording the exercises at rehab clinic

We first took the sketches to the rehab clinic, where we demonstrated how the hardware-sketches work to the therapists. The therapists then grouped up and discussed how best they can enact the possibilities of these sketches, finalizing an exercise scheme of four exercises including a stepping exercise. They introduced

the sketches to a senior citizen, undergoing rehab for hip-replacement, by demonstrating how they work. The citizen then performed the four types of exercises, which were video recorded by the laptop (figure 3B).

Exercising at Home

Following week, we took these recorded exercises to the home of the senior citizen where we first showed her what she did at the rehab clinic. We discussed how these videos from the rehab clinic could be useful at home, with the senior citizen and the therapists. We then asked the senior citizen to exercise using the sketches for monitoring her performance (figure 3C). These home exercises were video recorded with the webcam in a laptop.

Back at the rehab clinic

We made a series of 8 cards from the videos of the exercises from the rehab clinic and home. Each card had the title of the exercise along with select key-frames of the video. We asked the therapists at the rehab clinic to envision a scenario where the citizen will bring these cards to discuss how the exercises happened at home. We then set-up a discussion table with a TV screen connected to the laptop (figure 3D). Each card was connected to the video, and a team-member would pull up the video on the TV monitor when a particular card was picked up for discussion, employing the Wizard-of-Oz method.

We then summarized the three-part exploration in an extended discussion with the citizen and the therapists.

Early Reflections

Reflecting on this initial exploration of the first cycle of the MagicMirror spiral, we found out that:

- While the therapists were actively involved in exploring the sketches and setting up the exercises for the citizen in the first round, they were not so impressed by the amount of time it would take to go through the home videos of the citizens. The therapists rather found the sensor data to be more useful than the video material. The sensor data was more close to their expert language and they could relate to that closer than the video.
- However, the citizen expressed that the video from the rehab clinic would help her in reflecting on her progress. She was not comfortable with the overlap of exercise videos from the rehab clinic over the live video while exercising, and suggested that she would rather look at the videos from clinic separately for reflection on her progress.
- The citizen stated that recording her exercises at home to show it to the therapists would mean that she has to commit herself to the practice.

This would mean an external motivation for her to be engaged in the process: a “whip” in her terms.

From these initial reflections, we realized that the self-monitoring of exercises at home gives way to reflection and an awareness of ones progress in the ongoing process. Simultaneously sharing of this recorded data with the therapists gives the senior citizens a ‘language’ to discuss their experiences from home. While the therapists have an established ‘language’, based on bodily measurements, to talk to the citizens, the citizens did not have concrete tools to talk to the therapists about their embodied experiences in everyday life beyond the rehab clinic.

The central takeaway from the exploration was the fact that the recorded data simultaneously plays two different roles:

- Supporting self-reflection and increased awareness for senior citizens by providing opportunities for *self-monitoring* while exercising at home.
- Enhancing the *collaborative articulation* of the senior citizens’ rehab process with their therapists by giving them concrete language to share their exercise practices at home.

This simultaneous facilitation supports the two aspects to be entangled narratives of the same rehabilitation process, and calls for a shift in focus: *from designing isolated tools for rehabilitation to taking account of possibilities for collaboration*.

This realization of the need for a shift led us to the designing of MyReDiary. As described above, MyReDiary aims to support the three facets of collaborative articulation of a rehabilitation process. Below we describe the first electronic sketch of MyReDiary and the early experiences of the senior citizens trying it out.

Sketching and Experiencing MyReDiary

Based on this early feedback, we sketched an interface that visualized both the sensor data and corresponding video data. We supported this with information about how active the senior citizens were on each day at home to provide a brief overview for the therapists (figure 4A). Along with this electronic sketch, we drew up some possible scenarios of use and took them back to the rehab clinic.

As with the previous explorations, the therapists took ownership of the exploration, scripting the trials. They had chosen four senior citizens for this exploration, and asked each one of them to try out the sketch that recorded their exercises through sensors and video. Further they asked one of them to act out his first day at the rehab clinic after surgery (Figure 4B). After this, the recorded video and sensor data was shown to the citizen and therapist. They followed this with a general discussion of the sketch and the scenarios (Figure 4C).



Figure 4: Sketching and Co-Designing MyReDiary

Reflections

Reflecting on the co-designing of MyReDiary we can see how it supports the three facets:

Interdependence

MyReDiary provided opportunities for the senior citizens to record the exercises and therapist suggestions at the clinic and bring them to home for reflection. Further they can record the exercises at home and bring them to the therapists, thereby bringing a richer picture of everyday situations of exercising at home. This movement of exercise data supports a two-way consultation between the two experts.

Distributed Process

MyReDiary obviously facilitated the movement of the exercise data from clinic to home and back. Further the recording of the exercise and self-monitored data makes it available for access for getting an overview of the process and articulate further steps.

Interoperability

The more important thing MyReDiary does is to provide a language for the senior citizens to express their situation with the therapists. As we realized the senior citizens do not have an established language similar to the therapists. MyReDiary enables the citizens to record and annotate the everyday situations at home by videos, audio notes and pictures. Simultaneously it overlaps the quantitative data from the sensors over this data thereby providing different entry points into the shared data.

Thereby, MyReDiary holds the possibility of supporting the three facets of a collaboratively articulated rehabilitation process.

Compositional Whole

Looking back, we started with a conceptual understanding of collaborative articulation and its three facets. When this met the particular design situation, we formulated the Magic-Mirror-Spiral design ideal, which drove us to explore possible and desirable future states supporting collaborative articulation. This exploration of the conceptual understanding in the particular design situation led us to the design of MyReDiary, which as described above becomes one of the instantiation of designing for the three facets of collaborative articulation. As argued by our recent work (Bagalkot et al 2011) this cycle of interplay forms a *compositional whole* constituting the conceptual understanding of collaborative articulation, the Magic-Mirror-Spiral design ideal, and the designed MyReDiary artifact.

Concluding Remarks

Recent work in designing for collaborative articulation (Björgvinsson & Hillgren, 2004; Hillgren & Linde, 2006) has been exploring the recording of instructions by the therapists in the form of video as a language that citizens understand, on one side. On another, works have explored the design of digital technology to support patients to record their activities outside clinic to share them with their therapists (Sokoler et al, 2006; 2007). The *compositional whole* presented here, with its interrelated constituents, is our contribution to advance these recent and ongoing efforts: it as an example manifestation of designing for collaborative articulation in specific design situation. Further we enhanced the concept of collaborative articulation by reflecting on our experiences in engaging with the design process and demonstrating how digital technology can be designed to support the three facets of a collaboratively articulated rehabilitation process.

Future Work

The work presented in this paper is work-in-progress. However, one of the challenges to address in future is that of the issue of ownership of data. While MyReDiary is envisioned to give ownership of data with the citizens, it may undercut the current 'ownership' patterns. This calls for exploring ways to provide opportunities for the therapists and the citizens to *negotiate* the means of sharing and owning the data. In future we plan to explore if and how MyReDiary be designed as a boundary object along with its current form of a personal device.

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