Health and Welfare IT Product Design: Lessons Learned from a Design Class

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Abstract
In this paper we describe the outcomes from a university design class focused on the design of systems intended to solve problems faced by health care professionals, patients and systems that support welfare or extended independence for older people. The students worked in groups for 10 weeks finding a suitable problem to solve, iterating and refining their designs, evaluating prototypes with users, and finally presenting their work as a potential product with a detailed plan for how the product would be sold in the market. The primary contribution of this paper is to share innovative design ideas with the design community and to reflect on lessons learned by the students who, for the first time, were designing robust prototypes that solve real world problems.

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H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
The user centered design approach can help in the design and refinement of prototypes that solve

problems or satisfy important human needs. As well summarized in [1], user centered design is fundamental to cooperative prototyping [2], cooperative design [3], ergonomics, usability, and experience design among others. The process of becoming a proficient technology designer and learning when to use the appropriate methods and skills involves building up technical proficiency, techniques of involving the user and solving problems. Actually doing design and involving experiential learning, experimentation with feedback and guidance [4] is perhaps where students learn some of the most critical skills including working within deadlines, carefully focusing resources and efforts most effectively, refining communication skills with users and interested publics, etc.

There are various examples of research that document the design refinements of a system and the lessons learned from user evaluation. Less common, however, are works that recount findings from working with groups of student designers who are tasked with finding and designing for a problem in the real world related to health, welfare, or rehabilitation. With freedom to choose and pursue a problem in the real world, what would IT design students select and what types of products would they design? What challenges would they face?

This paper is organized as follows: the design class and the design assignment are described, an overview is provided of the projects developed, and discussion is provided highlighting some of the lessons learned. It is our aim that this review of the challenges and achievements can remind other designers of important issues as we design technologies for health, welfare, and perhaps any time we as designers set out to improve the lives of others with our designs.

IT Product Design Project Class

As a required course at the end of the first year of bachelor studies, students in the IT product design program at the Aarhus University attend an intensive ten-week class in which they pull together all of the knowledge and experience from previous classes. Under tight deadlines, the students work in groups of 2-4 to design, iterate, and develop functional prototypes that demonstrate their skills in web technologies, physical design, physical computing, business plan development, and evaluation of prototypes. Therefore, the final product design should involve electronic sensing and/or actuation, communication using web technologies, and should involve a business plan for bringing the product to market. The 2012 class was tasked with finding a health, welfare, or rehabilitation related problem that could be improved through the design of a digital technology product. Students were free to choose any problem, ailment, illness, or related human need.

Each week, the design groups had to submit written assignments, which built up to a final written report. Their prototype products were continually evaluated by the instructors of the course to ensure that they satisfied the constraints of the assignment, and teaching assistants who have taken the class in previous years were available to the class to ask questions, share their experiences, and to obtain additional guidance as needed. At the end of the course, an exhibition was held, during which the students presented and demonstrated their product

prototypes to the general public and specially invited members of the business and research community.

Overview of Product Prototypes

We now provide an overview of some of the prototype concepts developed by the student groups. These can be broadly grouped into three categories including products focused on rehabilitation, medical monitoring systems, and products focused on improving general health and welfare. These systems are now briefly described.

WiRe: Whiplash Rehabber uses a head-mounted laser and camera tracking to aid testing and rehabilitation of whiplash patients.

ERAIS: Ergonomic Aiding Seat enables a nurse to correctly position a patient by monitoring pressure data from the wheelchair seat, which is displayed on the LED display at left.

Rehabilitation

There were four prototypes that focused on helping people undergoing rehabilitation from injuries including whiplash, knee injuries, arm injuries, and impaired flexibility. We now describe these briefly:

• **MoRe** (More Rehabilitation) is a knee brace that measures the position of the knee and uses that position to control an onscreen avatar in a game that encourages the patient to do their exercises correctly and regularly.

• **ZensIT** is a portable elastic resistance band with embedded electronics that measures exercises completed and uploads progress to a patient management system.

• **WhiRe** (Whiplash Rehabber) is a whiplash injury test system that can be used to build exercise games to encourage strengthening when appropriate. It utilizes a head-mounted laser, camera tracking and an online database to track progress.

• **KARES** (Kinect Aided Rehabilitation Exercise System) utilizes a Microsoft Kinect system to sense the body position in real time as the patient performs their rehabilitation exercises. By providing encouragement and game like features, the patient is motivated to give appropriate effort.

Medical Monitoring

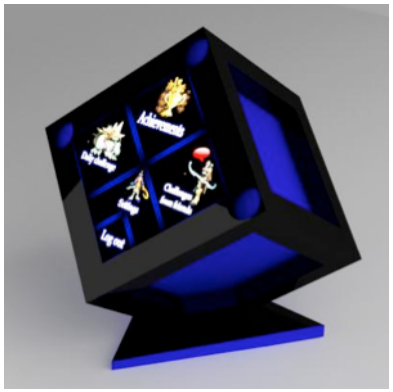
Four prototypes were designed to provide real time monitoring for critical health conditions and prevention of injuries. These include two systems that measure body position to prevent injuries, a system to monitor and maintain proper blood sugar levels for diabetics, and a medicine dispensing system. We describe these now:

• **HipBuzz** is a pair of undershorts with embedded sensors that prevent dangerous joint movements for hip replacement patients

• **ERAIS** (Ergonomic Aiding Seat) is a wheelchair positioning system that provides real-time visual feedback to nurses who position quadriplegic patients in order to prevent injuries from incorrect posture.

• **BlissTECH** is a diabetes management system for children and parents that continually measures and responds to the blood sugar levels of children in order to reduce blood sugar spikes and to encourage better self-management of diabetes.

• **HAPS'en** is a medication dispensing system for the home that ensures patients take the proper medications at the right time through a managed scheduling system, a desktop dispenser and portable pillbox.



Virtual model of the DareBox sensor with touch screen display tracks the exercise behaviors of the users and enables them to challenge their friends to complete exercise tasks.

Virtual model of the BeChange hub used to recharge the personal wristbands. The central hub encourages the family to work together toward their fitness goals.

Health and Wellbeing

Six of the groups designed prototype products that focused on improving health and wellbeing including two systems that encourage exercise through social engagement, two other systems provide new ways for families to remain connected, another system provides food allergy information at an in-store kiosk, and communication system simplifies the connected experience for older people in an assisted living residence. We now describe these briefly:

• **DareBox** is a Kinect-based system that measures exercise performance and encourages increased activity through an online social challenge system.

• **BeChange** is a family health and activity tracking system that involves a wristband that measures exercise performance, a shared scale to track weight loss, and a social motivation system centered around a control console in the home.

• **SMILE** is a communication system for families that enables older family members to send and receive emails with younger family members by allowing them to write a handwritten letter, insert it into a mailbox, and send it to the family member using a physical token. The family member can respond through normal email, which is delivered as a physical letter in the older family member's mailbox.

• **E-ROC** (Electronic Reminder, Organizer, Communicator) is a teddy bear based communication system that allows the family to communicate with each other through the tangible plush doll. It aims to simplify the use of electronic communication and enhance family ties through the caring feelings of the plush toys.

• **CHE** is an in-store interactive kiosk for people with food allergies. It enables the customer to scan an item and determine whether or not it contains ingredients to which they are allergic.

• **EaCe** (Easy) is an assisted living communication system with large simple button based navigation that enables older people to take a more active role in their assisted care by making food choices, rating service experiences, and communicating with others.

Lessons Learned

With 14 groups all designing different products, there were obviously many challenges that were faced and overcome. Of these, there were a few lessons that are particularly relevant for designers of health and welfare technologies. In the following paragraphs we discuss the challenges of the designer as an outsider, issues resulting from a compressed timeline, and domain specific technical challenges.

Designer as an Outsider

The students had to identify the most helpful potential users and learn quickly about real world problems they faced. The identification of an appropriate problem to solve was made easier by meeting with users with specific and detailed knowledge. Additionally, in some cases, healthcare professionals resisted new technology solutions, which required careful consideration and communication by the designers.

The design groups visited people receiving care, healthcare organizations and specialists attempting to

identify a relevant welfare problem and solution. Groups who got hold of healthcare professionals with expertise in specific areas or a patient organization with in-depth knowledge were able to provide better evidence for the generality of proposed product designs than where groups that identified and focused on a specific problem identified by just a few patients or recipients of care.

Many of the groups faced resistance from the medical professionals who claimed to not have enough time to spend with them. The students learned to research before visiting a clinic in order to be able to understand some of the terminology and to gain a sense of the types of activities involved in the respective facility. Some medical care professionals were worried that computers were increasingly taking over jobs and reducing professionals to maintaining machines in the future resulting in larger patient to caregiver ratios and less personal service. Some groups were able to address this concern by demonstrating how digital technologies can increase the quality of care, which ultimately is a goal they share.

Challenges of a compressed timeline

As noted earlier, the entire class lasted only ten weeks. Under these tight time constraints, the students had to speed up the development process carefully an mitigate challenges involving users with difficulties providing feedback, and conducting short user evaluations when refining the prototypes.

Various teams encountered users who were challenging to involve in the user-centered design process. For example, older people at nursing homes were in some case too weak to be involved or could only be involved for short periods of time. Additionally, people with temporary or permanent disabilities can be hard to involve practically in prototype evaluations, since that requires professional support and careful review before and during participation.

The main lesson learned from the compressed timeline was the renewed realization that user centered design requires long-term commitments and patience. This is especially true for technologies that engage users with reduced physical or mental capacities.

Domain-specific technical challenges

Designing prototypes for the healthcare or welfare industry often involves interfacing with other technologies that can be expensive or difficult to obtain. Furthermore, demonstrating semi-functional design prototypes requires careful trade offs in functionality and form.

As an example of challenges of special equipment, the team that designed the BlissTECH system required a continuous data feed from a wireless blood sugar sensor embedded in the patient's body. That new sensor technology is very costly and difficult to get obtain. Thus the conceptual prototyping process had to rely on many assumptions and simulations of the data stream utilizing Wizard of Oz techniques. Although this made it easier to demonstrate the design concept, direct user evaluation with live data could not be achieved.

Another example of this domain specific challenge of deciding where to focus efforts and resources came up in the ERAIS patient positioning system. The designers believed the system should be truly portable, however,

to build in wireless communication among components and install batteries for each component would take away their focus on the general design of the system. As a work-around, the design group tethered the device with control and power wires in order to focus efforts on improving the sensing, actuation, and physical design of the prototype in order to support evaluations of the system with users.

Conclusion

In this paper we described health, welfare, and medical product prototypes developed by technology design students in an intensive ten-week course. We discussed some of the lessons learned from the perspective of the instructors of the course with the objective of drawing attention to common issues and challenges faced when designers attempt to develop technologies.

This same intensive course is completed by all students completing their first year of bachelor studies in the degree program and serves as a useful way to activate knowledge gathered from technical, business, and design related courses. By following the progress of the students and reviewing the challenges they face, we can all be reminded to give more attention to well-known design practices, especially when designing systems for the health and welfare industry. The field of medical technologies is developing rapidly, with advancements on every front. In terms of digital technologies, the field is being revolutionized by the miniaturization of components and interdisciplinary design work i.e. embedded electronics in pills, etc. [5]. We encourage others to share their lessons learned as we work together designing systems that preserve and improve lives.

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