Analysis of Emergent Use for Wellbeing Service Innovation

Alexandros Yeratziotis[1], Christian Sannemann[2], Johanna Viitanen[3], and Marko Nieminen[3]

[1] Institute for ICT Advancement, Nelson Mandela Metropolitan University, South Africa
[2] Institute of Behavioral Sciences, University of Helsinki, Finland
[3] Software Business and Engineering Institute, Aalto University, Finland
Alexandros.Yeratziotis@nmmu.ac.za,
Christian.Sannemann@helsinki.fi,
{Johanna.Viitanen,Marko.Nieminen}@tkk.fi

Abstract. This paper presents a process of concept development for a new physical activity monitoring device. It forms part of a collaboration project between a Finnish health-technology company and Aalto University's Department of Computer Science and Engineering. There are two main objectives in this project; to develop and validate concepts for the company's product and to evaluate user interfaces that were built on the basis of these concepts. This will result in a set of new ideas for using and improving the service. The paper presents the results from the first and second phases of this three phase project. The first phase focuses on requirements from the health-technology company and how these were considered. Through an iteration process a set of three concepts were derived. In phase 2, these three concepts are visualized via storyboards. In phase 2, prototypes that were designed on the basis of the requirements are also assessed.

Keywords: concept development, obesity and overweight, physical activity monitoring device, user-centered development.

1 Introduction

Physical and mental activities both contribute to the overall well-being and good health of the individual. In the modern era the physical activity of children and adolescents has been degrading alarmingly. This results in serious health concerns at the individual level. For the first time ever, there is reason to believe that an emerging generation has a lower life expectancy than its predecessor [1]. As an example, every third child in the US is obese or overweight. Similarly, the numbers in Europe are also increasing rapidly. In terms of ICT, physical activity monitoring devices and online health services are being developed to assist people in becoming more active. They attempt to promote a healthier lifestyle and motivate people to achieve this. This paper describes an iterative concept development process for a new physical activity monitoring device and online health service. New concepts need to be developed and existing concepts need to be improved. The time span for this project is six months.

A. Marcus (Ed.): Design, User Experience, and Usability, Pt I, HCII 2011, LNCS 6769, pp. 332–341, 2011.

1.1 The Problem: Obesity and Overweight

The World Health Organisation [2] defines overweight and obesity as "abnormal or excessive fat accumulation that presents a risk to health". The most useful population-level measurement to calculate obesity is the Body Mass Index (BMI). The BMI can be applied for both sexes and for all ages of adults. However, one should consider it as a rough estimate because it may not correspond to the same degree of fatness in different individuals. It is understood that a person with a BMI of 30 or higher is considered to be obese, while a person with a BMI equal to or more than 25 is considered overweight.

The probabilities of premature death and disability in adulthood increase with childhood obesity. Being obese or overweight is clearly a considerable risk. It can also contribute to other chronic diseases. These include diabetes, musculoskeletal disorders, cancer and cardiovascular diseases. This is a problem that only used to be associated with high-income countries. However, obesity and overweight are also rising in low- and middle-income countries as well [2]. Obesity and overweight are caused by an energy imbalance. This imbalance relates to calories consumed in comparison to calories expended. The two main factors that contribute to this imbalance are bad diet habits and decreased physical activity [2] [3]. In an attempt to address these two factors, several methods have been suggested to prevent or reduce obesity and overweight [2] [4]. These include achieving an energy balance and healthy weight, increasing physical activity and having a healthy diet. These are methods that can be taken at the individual level.

The problems of obesity and overweight can be tackled with political commitment and collaboration. Stakeholders from the public and private sector have a critical role in the formation of healthy environments. In particular, healthier diet options that are affordable and easily accessible and the promotion of physical activity should be top priorities [2].

1.2 The ICT Approach: Physical Activity Monitoring Devices

As mentioned previously, one solution to reducing or preventing obesity and overweight is to increase physical activity. In an attempt to help people achieve this, stakeholders from the private sector have introduced a variety of physical activity monitoring devices and health services. Most of these devices can be categorized under two core groups; pedometers and accelerometers or multi-sensor activity tracking devices [5].

Pedometers can monitor human activity, like running or walking through the use of motion sensors. They are also referred to as step counters, as they measure the number of continuous steps that a person does. The more recent models have additional capabilities; measuring distance walked, energy expenditure, activity time, heart rate information, GPS (or integrated within cell phones), and BMI information. These devices are portable and wearable and tend to be a good motivator for daily exercise. However, they are still limited in the types of activities that they can monitor. They are mainly used to monitor walking and running activities. In addition,

they are well-used in healthcare research and clinical experiments [5]. Some popular devices are the Nike+iPod sport kit, the Nokia 5500 Sports phone, Omron HJ 112, Addidas miCoach Pacer, HJ 720 - ITC and the SportLine 955 pedometer watch. Multi-sensor activity tracking devices overcome some of the limitations found on conventional pedometers and accelerometers. They are also becoming more popular because people require more information regarding their physical activity. As the name implies, these are multiple sensing devices that record physical activities. The sensors are deployed at different areas of the body and are therefore focused on different physiological measurements. As a result, more comprehensive and convincing data of an individual's physical activities can be recorded. Examples of multi-sensor activity tracking devices are the Sensewear armband and the BioTrainer activity monitor [5].

2 Background

Literature review was conducted in the areas of concept development and User-Centered Design (UCD).

2.1 User-Centered Concept Development Process

To integrate users in the formulation of new concepts, the user-centered concept development (UCCD) process was considered. It is defined as a "cross-breed mixture of generic product development, utilizing technological advances and human-centered approach" [6] [7]. The UCCD process has five phases that assist the process of concept development. It helps in formalizing the development into manageable phases for easier adoption. This makes it possible to apply good practices and methods in each phase by taking into account their individual characteristics. The phases and their outcomes are presented in table 1 [8].

Table 1. Phases and outcomes of the UCCD process [8]

User-Centered Concept Development Phases	Outcomes
Phase 1 - Project Commitment: Define user group and con-text, select technology framework, schedule the project	Design brief
Phase 2 - User and Technology Research: Select research methods, conduct user and technology research, analyse data	User tasks and needs description, technology trends and possibilities
Phase 3 - Innovation Sprint: Generate ideas, be creative, do not criticize	Hundreds of ideas
Phase 4 - Iterative Concept Creation and Validation: Select and combine, visualize, validate	Validated concept candidates
Phase 5 - Project Assessment: Evaluate concepts against requirements, collect customer feedback, prioritize concepts and propose future steps	Final concepts, project documentation

2.2 User-Centered Design

The purpose of UCD is to develop products with a high-degree of usability. To achieve this, the user becomes the center of focus in the product development process. Usability is therefore the outcome of applying UCD in the development. UCD is defined as "a user interface design process that focuses on usability goals, user characteristics, environment, tasks, and workflow in the design of an interface; it is an iterative process, where design and evaluation steps are built in from the first stage of projects, through implementation" [9]. To better understand the concept on which UCD is founded, it would be beneficial to first compare it to an alternative approach that is used when developing software products; the system-centered design approach (SCD). The design of a new system in SCD is highly focused on the actual characteristics of the system. For example, designing a product that is to run on a particular platform will evidently influence its design process. This is because the new system will need to be designed in such a manner that it optimizes and fits into the platform for which it is intended [10]. In UCD however, the focus of the design is not based solely on the system characteristics, as is in SCD. Instead, it is based on the fundamental objective to best address users' needs and their tasks. This is the vehicle that drives the design process. The needs and tasks of users must also be in line with what is stated in the requirements documents. It is even possible to sacrifice certain system efficiency in order to address users' needs with regards to their interactions with the interface [10].

It is evident that UCD depends on the participation of the intended users of a new software product, throughout the design process. However, the approach that the Finnish health-technology company adopted in their design process tends to adhere more to the SCD process. The project will now attempt to include certain user involvement at the end of design process. This is not the correct manner in which to do UCD but is deemed necessary, even at this point.

2.3 Introduction to New Technology

The device itself is a combination of a multi-sensor activity tracking device and a conventional pedometer and accelerometer. The technology has two key components; an activity logger and a web service. It uses a 3D acceleration transducer and patented algorithms to identify the individual user. The user identification process is based on the actual movements of the individual; each person has their own unique style of movement that distinguishes them from the movements of others. By identifying an individual based on their movements it becomes possible to automatically and accurately determine the type and amount of activity that is being performed by that individual. As with the other devices, this device is also worn by the users during physical activity. Once the users have completed their physical activity they can then connect their device into the USB port of a computer. The data from their last activity will then be uploaded to the web service. Some of the additional capabilities include an activity diary, automatic activity duration recognition, measuring calories burned, training effects (e.g. endurance, strength, etc.), and a long battery life. The most important feature differentiating it from other similar devices is automatic person

identification by comparing patterns to samples. In addition, the technology will soon be able to do automatic activity recognition as well, beyond just the standard activities of walking and running (e.g. sleeping, football, etc.).

The problem with the device does not pertain to the functionality of it but instead is focused on the user aspect and usability thereof of the service. This problem is associated with the fact that it is a technology-driven project. This is a controvert case in wellbeing human-computer interaction (HCI) research as in a traditional UCD process, the design is based upon explicit understanding of users, tasks, and environments. However, in this case the potential users will only be involved in later phases of concept development, after the technology and service has already been developed.

In an attempted to improve the usability and user experience of the service, a new project was initiated. It was a special group project for students. The project team consisted of six postgraduate students, some with industry experience, and two supervisors. The team provided a wealth of knowledge, interests and expertise from a variety of research areas, such as usability and user experience for the PC and mobile platforms, security and privacy, usability evaluation methods, software engineering and development, and cognitive sciences.

3 Results

The main objective of the project was to generate concepts for the technology. These included new concepts, as well as improvements on their current services. The project started in October 2010. The planed duration for completion of the project was estimated at six months. Based on these time estimates, the project was divided into three core phases: In Phase 1, concepts would be created by the project team on the basis of stakeholder requirements. In Phase 2, ideas in the form of features and designs would derive from student prototype designs. In Phase 3, concept validation would be conducted. This would assess the concepts and features from Phase 1 and 2 respectively. The final outcome would be a set of master concepts. Phases 1 and 2 will be discussed in this section because it is work that has been completed or is currently under progress. Phase 3 of the project will be mentioned in the Discussion section as it has to be yet conducted.

3.1 Concept Development Activities for This Project

Before the first and second phases of the project are discussed in more detail, an overview of how the UCCD process (from table 1) was applied in this project is presented. This will assist in understanding the objectives of each phase from the process perspective as well. It must also be noted that at present this project is at Phase 4 of the UCCD process. Table 2 presents the outcomes of each phase of the UCCD process with regards to this specific project. The table also displays the status of the phase, which is either “Completed”, “Current work” or “Future work”. The phase of the project that each phase of the UCCD process relates to is also provided.

Table 2. Outcomes of the UCCD process for this project

User-Centered Concept Development Phases	Status	Project Phase
Phase 1: Base set requirements was defined and a project plan was created.	Completed	Phase 1
Phase 2: Literature review in the area of physical activity monitoring devices and services was conducted and research methods were defined. Each member of the project team also conducted research into their own fields that would contribute to the project.	Completed	Phase 1
Phase 3: Based on the research methods in Phase 2, an idea session was conducted that resulted in 115 ideas. The ideas were analysed and combined to develop three concepts.	Completed	Phase 1
Phase 4: The three concepts from Phase 3 need to be visualized. This will be achieved through storyboards.	Current work	Phase 2
Phase 5: A concept validation session will be conducted with users to assess the three concepts from Phase 4. The results will be analysed and the concepts will be improved. A final report will be created for the project.	Future work	Phase 3

3.2 Phase 1: Requirements Elicitation

After several meetings with the company a base set of requirements were determined. These requirements would direct the project scope and goals regarding the concepts. They were particularly significant for the UCCD process. The requirements included: 1. The target audience – the concepts should be focused on the layman adult user. 2. Information presentation – how to display the activity data to the intended users without overloading them with complex data? 3. Useful information – how to make the activity data useful to the intended users? This entails determining what is perceived as useful information by the users. 4. User experience – the concepts should be fun and simple to use for the intended users. 5. Motivation – how to keep intended users motivated and not lose interest in the technology? 6. Integration – how could the technology integrate with other existing services?

A more detailed description of the last part of phase 1, the innovation sprint, will now follow. A day idea session was conducted. For setting the mind before the idea generation process started, members of the team presented interesting findings from their literature reviews as well as discussed the base set requirements. The first method that was applied was the 3-3-5 x 2 technique, a modified version of the 6-3-5 x 2 technique. This modification was due to time constants. The modified technique required three members, thinking up three ideas every five minutes and passing them on for others to develop. As the project team consisted of six members, the ideas were developed by two groups consisting of three members in each. In total 18 initial ideas were constructed all of which were developed twice. Following right after, a brainstorming session was conducted. The ideas from both these techniques were discussed and analyzed and an affinity diagram was developed. After filtering out duplication, the idea session produced a total of 115 raw ideas. The ideas were

divided in ten different concept categories within the affinity diagram. These can be regarded as the first-round concept ideas and are displayed in figure 1 as the "10 FIRST-ROUND CONCEPTS". A more in-depth analysis was done after the creation of the ten first-round concept ideas. Some concept ideas were combined and others were improved upon. This resulted in the formulation of eight second-round concept ideas, which are displayed in figure 1 as the "8 SECOND-ROUND CONCEPTS". A selection process on which three concepts would be further analyzed and visualized then followed. This also included discussions with the stakeholders, regarding the concepts. Once again, an in-depth analysis of the eight second-round concepts was conducted. This was done in order to progress to three third-round concepts. The improved concepts that were selected for transformation into visualizations were: 1. Social media game, 2. Instructional and entertaining information, 3. Safety and health device for the elderly. These are displayed in figure 1 as the "3 THIRD-ROUND CONCEPTS".

3.3 Phase 2: Prototyping the Services

The aim of this phase is twofold: to provide useful features and design elements that could be incorporated into the three third-round concepts from Phase 1 and to visualize those concepts for validation in Phase 3. The features and design elements would be derived from student prototypes. These were assignments given to about forty students in an undergraduate course. Based on the concepts and stakeholder requirements from Phase 1, the students were provided with health and well-being scenarios for their prototypes. Once selecting a scenario, students would have to create three types of interfaces for it; CLI (Command Line Interface), GUI (Graphical User Interface) and Web user interface. Although slightly differing from the concepts to be visualized and validated in phase 3, all scenarios were relevant in that they considered three critical requirements: motivation, information presentation and integration with other services. The six scenarios displayed in figure 1 as the "HEALTH & WELL-BEING COURSE SCENARIOS".

The assistant instructor of the course, whom was also a member of the project team, assessed about eighty prototypes to determine the top ten prototypes. The top ten prototypes were then analyzed by the project team. A total of nine interesting ideas resulted from these assessments. Some ideas were: 1. Implementing graphs that display different qualities that are specific to the type of exercise (e.g. boxing is an exercise that is associated with strength, so the user would be interested in information about strength and flexibility). 2. Displaying rewards that would be of interest to the intended users as pictures (e.g. spa days, free newspaper edition). 3. Implementing graphs that compare the user's condition and activity levels (e.g. what is the activity offering the user; endurance or strength, which muscles are being affected by the activity, projections of future progress based on current activity levels, setting activity goals; short- and long-term, displaying achievement ratios of set goals). 4. Displaying the user's physical progress in a picture format (e.g. this could be animations displaying the physical changes to the user's body over a period of time).

The ideas presented above were then visualized so that they can be included into the concept validation process in Phase 3, where possible. This would help determine the effectiveness and usefulness of the design features in each of the three third-round concepts. An illustration summarizing all the activities included in the project's three phases is presented in figure 1. Interconnections between the activities are also provided. At present, the project is in Phase 2: prototyping the service.

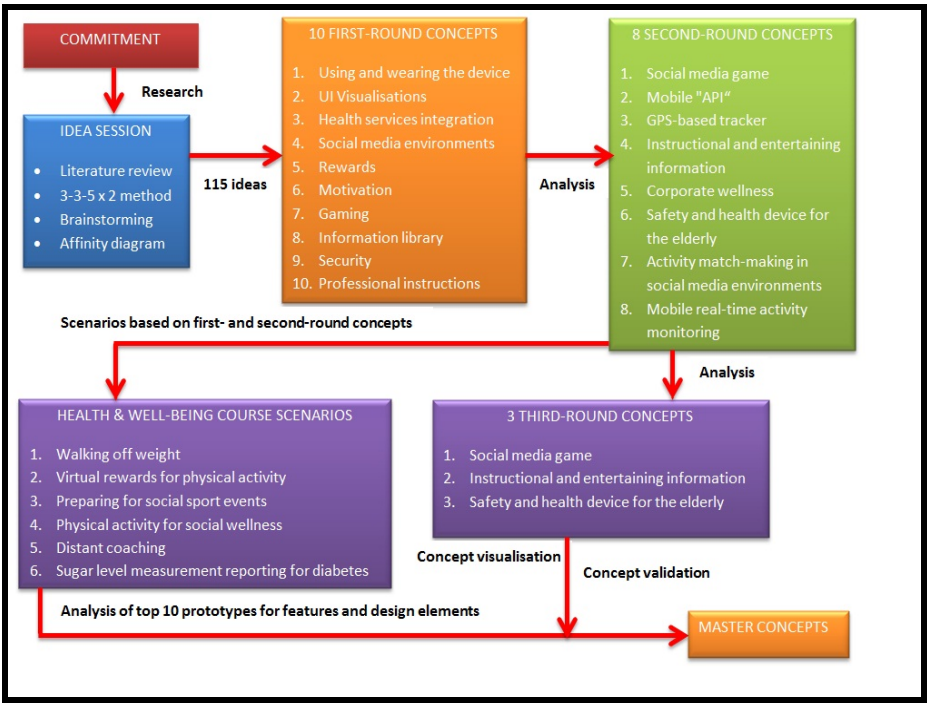

Fig. 1. The three phase process of the project and its activities

4 Discussion

As already stated, in phase 2, storyboard visualizations will be created for the three third-round concepts; Social media game, Instructional and entertaining information, Safety and health device for the elderly. These visualizations will then be used in the concept validation process. A brief description of how the validation will be conducted and the steps involved is provided: 1. Recruit users for testing the visualizations. Three to four users will be recruited for each concept. Therefore, a total of nine to twelve users will be required. The users will use the physical activity monitoring device in order to experience the visualizations in real context settings as well. 2. After testing, a focus group discussion will be conducted for each of the three concepts. The discussion will be focused on three key elements from the storyboards;

motivation, information presentation and integration of services. 3. The data will then be analyzed by the project team. Based on the analysis a final set of master concepts and a report will be provided to the stakeholders.

4.1 Demonstration of Storyboard Visualization for Social Media Game Concept

An initial representation of the storyboard for the Social media game is presented for demonstration purposes. The storyboard is still being improved and visualizations as to how the user is provided with options for physical activity during game play are still under construction. To summarize, the social media game concept is founded on the notion of users that are struggling to progress in a game (figure 2 - left). After a number of failed attempts, users will be provided with the physical activity option (figure 2 - center). If users agree to take the option, they would then temporarily interrupt their game and do some type of physical activity. They would be required to have the physical activity monitoring device with them during their activity sessions (figure 2 - right). Once they have completed their activity, they will then connect their device into the USB port of their computer (figure 3 - left). The activity data is then uploaded to a service, which will provide users with credits based on the amount of exercise done. The user can then use these credits in the game setting to improve their skills (figure 3 - right). This should provide them with the abilities to progress in the game.

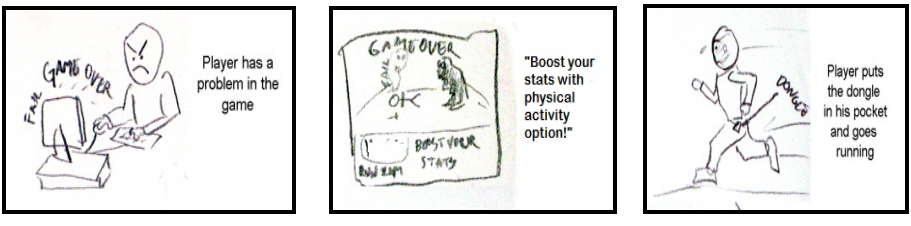

Fig. 2. User is not progressing in the game (left). User is presented with physical activity option (center). User accepts physical activity option and goes for a jog with the device (right).

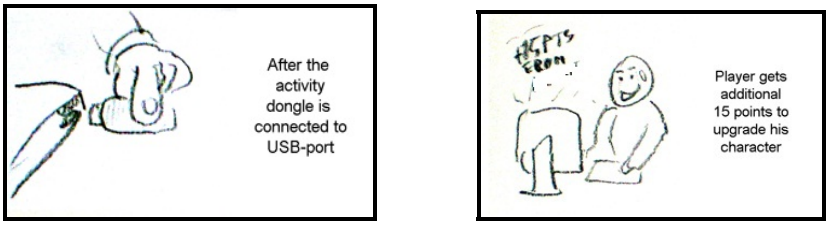

Fig. 3. User returns from jog and connects the device to the computers USB port (left). User receives 15 credits for the jog to improve game character (right).

5 Conclusions

The problem and implications of obesity and overweight are clearly understood. It is also evident that the amounts of people that are facing this problem are constantly rising at an alarming rate. In order to prevent or reduce this problem, several measures have been introduced. One of the measures is for people to increase physical activity in their daily lives. As a result, selections of physical activity monitoring devices are being offered. Their purpose is to help motivate people to exercise more and to provide them with useful activity information. This paper introduces a new physical activity monitoring device.The service for this new physical activity monitoring device was based on a technology-driven project. To improve the usability and user-experience of the service a new project was consequently initiated. The purpose of this project is to improve the current concept services as well as to create new concepts for the technology. o achieve this, it was first necessary to consider the UCD and UCCD processes. Based on the stakeholder requirements, the three main elements that were significant for concept development were motivation, information presentation and integration of services. The project was decided to be conducted in three phases, and is currently in Phase 2: prototyping the services. Phase 3 will initiate once Phase 2 has completed.

Acknowledgments. We thank our colleagues in the special assignment group and the Finnish health-technology company for their collaboration.

References

1. Olshansky, S.J., Passaro, D., Hershow, R.C., Laden, J., Carnes, B.A., Brody, J., Hayflick, L., But, R.N., Allison, D.B., Ludwig, D.S.: A potential decline in life expectancy in the United States in the 21st century. The New England journal of medicine 352(11), 1138 (2005)
2. World Health Organisation: Fact sheet N°311: Obesity and overweight (2006), http://www.who.int/mediacentre/factsheets/fs311/en/
3. NHS Choices: Causes of obesity (2010a), http://www.nhs.uk/Conditions/Obesity/Pages/Causes.aspx
4. NHS Choices: Treating obesity (2010b), http://www.nhs.uk/Conditions/Obesity/Pages/Treatment.aspx
5. Chen, C., Anton, S., Helal, A.: A brief survey of physical activity monitoring devices. University of Florida Tech. Report MPCL-08-09 (2008)
6. International Organization for Standardization: ISO 13407 International Standard: Human-centred design processes for interactive systems, Geneve, Switzerland (1999)
7. Ulrich, K.T., Eppinger, S.D.: Product Design and Development, 3rd edn. Irwin series in marketing. McGraw-Hill, New York (2004)
8. Nieminen, M. P.: Process Methods of User-Centered Concept Development. Licentiate's Thesis. Helsinki University of Technology, Department of Computer Science and Engineering (2006)
9. Henry, S.L.: Just Ask: Integrating Accessibility Throughout Design. ETLawton, Madison, WI (2007) ISBN 978-1430319528
10. Leventhal, L., Barnes, J.: Usability engineering: process, products & examples. Prentice-Hall, Englewood Cliffs (2007)