# Designing a Desirable Smart Bracelet for Older Adults

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## Abstract
In this paper, we present the design process of a smart bracelet that aims at enhancing the life of elderly people. The bracelet acts as a personal assistant during the user's everyday life, monitoring the health status and alerting him or her about abnormal conditions, reminding medications and facilitating the everyday life in many outdoor and indoor activities.

## Author Keywords
Smart bracelet; wrist-worn; personal assistant; elderly people; multimodal interaction.

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

## Introduction
The "Old Continent" is getting old: the European Commission is expecting an increase of 40% of people aged from 65 to 80 in the next 20 years, with a probable ratio between working and retired people in 2050 of only 2 to 1 [7]. In order to mitigate the financial crisis that this scenario could imply for most countries, the European Commission is stimulating a higher level of participation of elderly people in employment and expects longer independent lives that could decrease the cost of healthcare for older people

[8]. To this purpose, the "Ageing Well in The Information Society" program is an attempt to put Information and Communication Technologies (ICT) at the service of this heterogeneous category of people. However, practical and ethical questions arise: do older adults really need ICT? Are the proposed services meeting the expectations of older adults? According to a European study, more than 60% of people over 50 feel that their needs are not adequately addressed by current ICT equipment and services [8]. Thanks to the advance of technology, computing and monitoring sensors can now be embedded in small accessories; indeed, we are assisting to the boom of smart devices, e.g., watches, and bracelets. Several concepts, prototypes and market-ready devices have been presented [20,22,11,6,16,17], with attractive functionalities for either young or adult people of all social classes. The success of smart watches is probably due to the immediateness of wrist-mounted displays which are very effective for delivering alerts and notifications, as demonstrated by Harrison et al. [9]. Even if a smart bracelet could be very useful for elderly people, none of these products seems to explicitly address their special needs. Indeed, several medical bracelets for health monitoring exist [13,14,24], but their attractiveness is limited by the socio-emotional drawback that those products have on elderly people [3].

In this paper, we try to meet the older adults' needs with a new concept of wearable assistive technology: the proposed smart bracelet not only offers health monitoring functionalities but aims also to facilitate everyday indoor and outdoor tasks. Following Bright and Coventry's guidelines for the design of assistive technologies [3], we will focus our attention on two main topics: a) aesthetic design features and b) aligning usefulness and usability with desirability. To this purpose, we will carefully define the smart bracelet aspect (aesthetics) and functionalities (usefulness), taking into account the socio-emotional implications of such a product; moreover, we will design a multimodal interface for the smart bracelet (usability), in order to improve the accessibility and overcome possible physical and cognitive impairments that often occur in elders [19]. The paper is structured as following: in Section 2 we describe the overall *innovation process* that generated the idea of the smart bracelet for elderly people and that aims to validate the proposed concept; in the following sections we detail the second phase of the innovation process: we analyze the existing systems in the market (Section 3), we ground our aesthetics, functionality and interface design on existing guidelines (Section 4, 5 and 6) and we analyze the remaining challenges for the development of the smart bracelet (Section 7); finally, we present the undergoing interview process that aims at collecting feedback on the concept with people aged between 50 and 91. This feedback will be used to refine the design of the product. The complete results will be presented during the workshop.

## Innovation Process

The design of the smart bracelet has been conducted by a multidisciplinary team with competences in interaction design, product design, marketing, and engineering, in the context of the marketing and innovation course[1] included in the Bachelor of Science in Business Administration of the HEIG-VD (School of Business and Engineering Vaud). The idea of the smart

[1] http://www.option-marketing-innovation.ch/

bracelet for elderly people is achieved following an innovation process that consists in 3 phases [2], started in September 2012 and finishing in July 2013 (Figure 1). The entry point of the idea generation process was the definition of a smart personal object, an object that could enhance the user life by adapting its interface and functions to the user's needs and to the context information. The three phases are articulated as following:

*Phase I – Creativ'Idea*
Development of a book of ideas presenting new applications based on a specific technology through different brainstorming sessions.

**Technology to be evaluated**

A particular technology (in this case smart personal objects) is the entry point of the innovation process.

**Generated Ideas**

The smart bracelet for elderly people has been selected among a total of 15 different concepts of smart personal objects. Many ideas associated during the generation to rejected concepts converged in the definition of the smart bracelet.

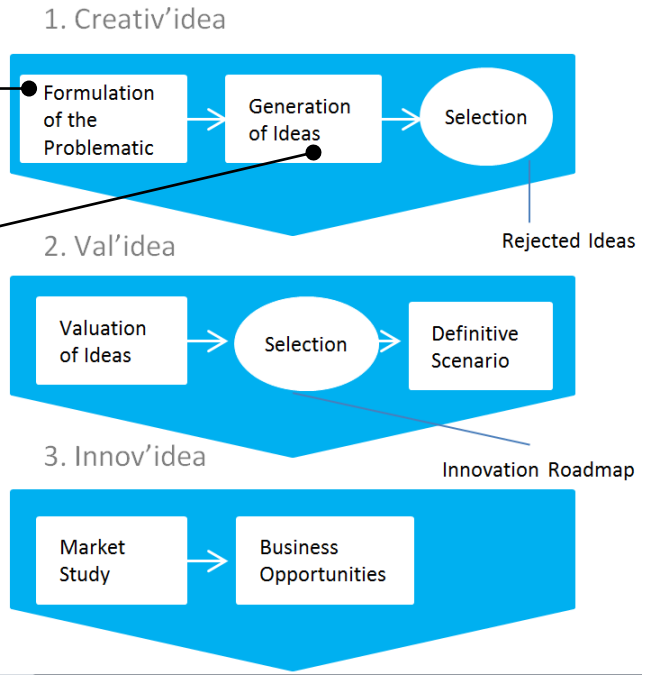


**Figure 1**. Innovation process schema.

*Phase II – Val'Idea*
Identification of a concept for a smart bracelet for elderly people, evaluation of its market and research potential, feasibility research for the required technologies and first design of the concept.

*Phase III – Innov'Idea*
Development of communication tools of the chosen concept (mock-ups and video) and a user inquiry on the proposed concept, a functionality refinement and a user evaluation with the mock up as well as a market potential evaluation using the Business Model Canvas [18].

In this paper, we present the results obtained during the second phase of the innovation process. The following step, briefly described at the end of this paper, will be concluded in the next months and the results will be discussed during the workshop.

## Related Work

At the beginning of the current year, the popular website CNET argued that 2013 could definitely be the year of smart watches [5]. The interest in smart watches is probably determined by their ready-to-hand functionalities and notifications from the smartphone [8]. Pebble [20] and Sony Ericsson LiveView [22] are two popular examples of smart watches that offer SMS and App notification from the smartphone. Despite the large amount of notifications that can be delivered by the smartphone to the watch, in both Pebble and LiveView the information is shown in a small screen and the user need to navigate in the interface with small

**Figure 2**. Sketch of the smart bracelet: on the left the men's model, on the right the women's model

**Figure 3**. Eight customizations of the smart bracelet

physical buttons or small touch zones, which are generally very cumbersome for older adults. The Jawbone UP bracelet [11] is probably the most interesting product for elderly people, although it is not explicitly designed for them, because of its intuitive interface. Rather than displaying information in an unreadable screen, UP notifies the user through a vibration motor and two LEDs. UP offers activity and sleep monitoring functions that can be analyzed in the smartphone by downloading the stored data. Unfortunately it does not have wireless communication and it cannot deliver notifications from the smartphone to the user. Conversely, the Embrace+ bracelet [6] offers RGB LED as configurable notification from the smartphone, but it does not provide monitoring functions. Commercial activity monitoring devices exist for sport purposes and they generally spot heart beat rate measurement and actigraphy (see the Motorola MOTOACTV [16] or the Nike+ FuelBand [17]). Most commercial bracelets for elderly are GPS trackers for people affected by dementia [13], SOS watches that allow calling for help in case of emergency [13,14] or falling detection bracelets [24]. Several medical bracelets for health monitoring exist but they are generally focused on measuring one or two parameters, for particular pathologies [1]. The AMON is probably the first wrist-worn sensors for multi-parameter monitoring, offering also activity recognition and emergency detection [1]. Users that tested AMON said that the device could provide a feeling of security if they were suffering of risky pathologies, allowing them to resume their social activity. Besides the positive valence of assistive technologies, the study of Bright and Coventry showed that also a negative valence could occur, which is derived from the psychological and socio-emotional costs of needing this aid [3].

Mixing the health monitoring functions of the device with an attractive non-medical design and with functions that facilitate everyday indoor and outdoor activities could improve the desirability of the whole product. Thus, the contribution of this paper is a new approach for the design of a wrist-worn assistive bracelet, which aims at improving the desirability of the product, balancing aesthetics, usefulness and usability with socio-emotional costs.

## Aesthetics Design

Following Bright and Coventry's guidelines we have chosen to give to the smart bracelet a *non-medical behavior* in order to avoid ageist stereotypes [3]. The smart bracelet has a modern and minimalist look, thanks to the simplified interface (Figure 2). We believe that this design could *elicit curiosity and interest* not only in older adults but also in a large variety of people, making the product more attractive and facilitating the early adoption of the product. We planned to offer *personalized options* of the smart bracelet by proposing different colors, optional functions and a lighter version for women (Figure 3).

## Aligning Usefulness with Desirability

Bright and Coventry [3] suggest providing *diversionary features* in order to draw away the attention from the medical purpose of the assistive device. To this purpose we propose a set of functionalities that can enhance the user's everyday life. We propose seven functionalities, which are depicted in Figure 4:

1. Digital payment for shopping
2. Digital payment for transportation

**Figure 4.** An image that depicts the seven functions of the smart bracelet.

3. Health monitoring and alert (e.g., hydration)
4. Health data storage, for facilitating healthcare diagnosis
5. Message notification from the smartphone
6. Multimodal interaction with home appliances
7. Reminder

The first two features facilitate outdoor activities like shopping and taking transportations thanks to a digital payment system. Promoting outdoor activities has several benefits: older adults can have an active social life and the correlated physical activity is able to cope with the sedentary lifestyle typical of some older adults. Both have been proven to improve health and cognitive status of older adults [23]. Associating the smart bracelet to health and vitality is definitely a "*counter-stereotypes*" that can boost self-esteem and facilitate the acceptance of this assistive technology. Therefore, also the health monitoring features could be associated to a more active life, rather than to a negative valence: by wearing the smart bracelet the user could feel safer and more confident, even during outdoor activities. The health data storage could generate privacy concerns, thus, the user should have the possibility to disable the log of health data. Moreover, only authorized medical staff should be allowed to read and analyze those data. The message notification from the smartphone is a particularly useful feature for older adults with hearing impairments. Ageism will not be triggered, because it is a common feature that is present in many wrist-worn devices, very useful also for younger people. Multimodal interaction with smart appliances is a feature that aims at improving the indoor life of elder people, by making the interaction with household appliances more natural and simplified [10]. The many advantages of multimodal interaction will be shown in the next section. The reminder is a generic alarm that could be associated to the smartphone calendar for important events or to a medication reminder. The latter is presented as optional because it could trigger ageism.

## Aligning Usability with Desirability

Most interfaces proposed so far for smart watches offer limited accessibility to older adults: screens are small and information is often showed with small characters; small buttons are used to navigate in the interface. Designing an interface that takes into account most common perceptual impairments of older adults is important to increase the desirability of the whole product. Jacko et al. suggest using multimodal interaction in order to support a wide range of perceptual capabilities [10]. Multimodal interfaces allow the user to communicate through a combination of modalities or through the best of available modalities. These modalities can be chosen not only according to possible perceptual impairments of the user, but also according to the context of utilization. For example, auditory feedbacks and speech are not appropriated for some public environments or could not be effective in very noisy environments. Choosing the best modalities to interact with the smart bracelet (or with smart household appliances through the smart bracelet) could reduce errors and thus frustration during the utilization [10].

In 2006, Pattison and Stedmon proposed some guidelines to improve accessibility [19] of mobile

devices. While they applied these guidelines to smartphones, we found them very effective also for the design of the smart bracelet interface. In their paper, the effects of aging were classified among four main factors: vision, hearing, hand function and cognitive process. Most common *visual impairments* in older adults are related to a decreasing visual acuity, decreased contrast sensitivity, a worsening ability to focus on near and far objects and difficulties with glare. To cope with these visual impairments we conceived a simplified interface, which provides visual notifications through an e-ink black and white screen. Unlike the Pebble smart watch, information is presented through intuitive icons, avoiding small characters in the interface. The e-ink screen offers high contrast even in sunlight and avoids glares typical of many commercial OLED or LCD smartphone screens. Gradual *loss of hearing* is often associated with aging: Pattison and Stedmon suggest to avoid the use of high frequency audio feedback and to keep auditory feedback as simple as possible. In our smart bracelet, visual notifications will be coupled with simple vocal messages that should help the user to remember the meaning of the icon. Although speakers that can be integrated in a wrist-worn device are generally quite weak, they are often easier to hear in respect to a phone that has been left in another room, in a bag or in a pocket. Moreover, notifications will be coupled with a haptic feedback produced by a vibration motor. Older adults' motor functions often experiment a *decrease in strength, dexterity and range*: we avoided small physical buttons and we simplified the interface to a single and large touch zone over the notification screen. The user will touch this zone to confirm that he or she has noticed the notification or to confirm the proposed action (for example to pay). By covering the bracelet with the whole hand the user can delay notifications or refuse actions. This simplified interaction is also intended to facilitate the learning phase of the bracelet interface which is slower and more difficult in older adults, because of *reduced cognitive functions*.

## Product Design

In order to understand the possible limitations that the available technologies could impose in respect to the proposed design of the aesthetics, the interface and functionalities, we conducted a preliminary feasibility study. Three main challenges have been identified during this phase.

*Product as service: partnership with institutions*

The proposed features go far beyond the smart bracelet. The possibility to digitally pay with the smart bracelet requires the support of advanced technologies in shops and by credit institutions. The Near Field Communication is becoming a reality for digital payments and we believe that in few years this technology could reach a broad adoption in many countries [4]. Similarly, the possibility to analyze health data and to store medical information in the bracelet should be supported by healthcare institutions. In both cases, we believe that the cost of the infrastructure could be balanced by a gain in efficiency and efficacy. Smart household appliances require also the adoption of worldwide recognized standard to support an external interface such as the smart bracelet. A good example of worldwide recognized standard that could be adopted as interface for multimedia appliance is that developed by the D.L.N.A. [2]

[2] http://www.dlna.org/

*High computational power versus form factor*
Always available health monitoring and activity recognition requires high computational power, which in turn implies a bigger battery. Even an advanced low power microcontroller could not grant a daily-long activity with the small battery that could be integrated in the concept depicted in Figure 2. Making the smart bracelet bigger could induce pain in the user, thus a different approach should be adopted. Following Raffa et al.'s hybrid computational approach [21], high power demanding computations could be executed in the coupled smartphone in order to reduce the power requirement of the bracelet.

*Number of features versus small form factor*
Some proposed features and some particular health parameters to be monitored could require a bigger size of the smart bracelet, which could be cumbersome for the user. The interviews aim to identify which are the most relevant features for older adults and will select them according to the space requirements for integration and to the perceived usefulness.

## User Inquiry

In order to validate or refine our design choices, we conducted 14 semi-structured interviews with 6 potential users (3 male and 3 female aged over 65), 6 future potential user (3 male and 3 female aged between 50 and 65, which have relative aged over 65), and 2 employees of a retirement home. The first part of the interviews aimed at investigating the user habits and needs in relation to assistance, health, transportation and technology. Afterwards, we presented our concept of the smart bracelet to the interviewed people through a video that depicts the 7 functionalities discussed in Section 5 and we asked their opinions about the perceived usefulness of the bracelet. In this paper, we briefly report only the most important findings relative to the second part of the interviews.

Among the 12 interviewed people, only one, aged over 65, judged the bracelet as not useful. Some features were perceived differently by the two categories of people: most of those aged over 65 said that they would not need the health monitor functions, while the younger group found this function very useful for their aged relatives. This finding confirms what Bright and Coventry suggest in their paper: the medical feature should not emerge in the product and should be presented as an accessory feature, which, however, will be appreciated by their relatives. Four people expressed the fear that such assistive technology could replace the need of physical assistance contributing to social isolation. In fact, assistive technologies often leverage similar ethical discussions [15]. Indeed, the aim of this bracelet is not replacing the human assistance, but, conversely, to facilitate and promote outdoor activities and therefore social interactions that can contribute to ameliorate and extend elders' independent life [23].

## Conclusion and Future Work

Designing smart accessories for elderly people implies several additional challenges in respect to products with a generic target. The perceived usefulness of the product is often affected by socio-emotional factors, while the interface requires special precautions to improve the accessibility. In this paper, we proposed the design of a smart bracelet that aims at improving elderly life by lowering the threshold to access everyday technologies, such as digital payments and

smart household appliances, and through health monitoring and alert functions. The design aimed at improving the product desirability, by carefully studying the aesthetics, the proposed functionalities and an accessible multimodal interface. Besides the common challenges for technological integration, many features require an extended effort of integration with existing and future services.

Following a user centered approach, our design process will involve several iterations and evaluation of prototypes with older adults. The preliminary interviews will be used to refine the product design in order to create a new mockup that will be used to conduct a usability evaluation. The proposed features will be simulated using a Wizard of Oz technique [12]. Analyzing the result of this second evaluation, we will build a functioning prototype that will be tested again by older adults.

Designing wearable systems for older adults is challenging and it requires a large flexibility in order to adapt the product to this heterogeneous category of people. Furthermore, this flexibility should also consider the changing requirements that will be introduced by the next generation of older adults, which have a different relationship with technology. These considerations could raise an interesting debate about how the design process of smart accessories for the old age could be influenced by this prominent need of flexibility.

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